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Superfund Treatability Clearinghouse Abstracts

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These abstracts were compiled to provide information on treatability studies that have been conducted at hazardous waste sites. The studies presented contain treatability data only on technologies for treatment of soil and debris. The clearinghouse may address other media in the future. The abstract provides operational and performance information as well as identifying the primary contaminants of concern. A contact is identified to obtain more specific information about the site and/or tests conducted.

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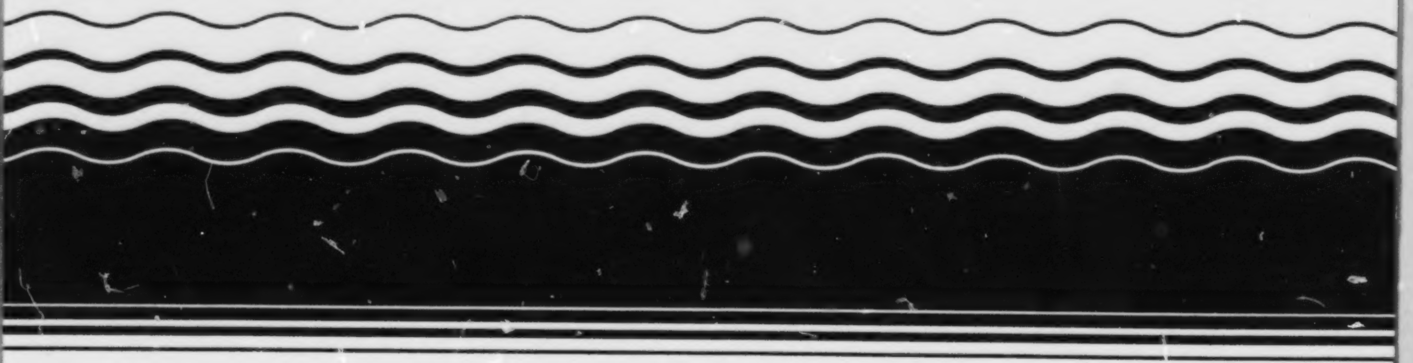

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Office of Solid Waste and Emergency Response
Office of Emergency and Remedial Response
U.S. Environmental Protection Agency
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Disclaimer

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Executive Summary

The Superfund Treatability Clearinghouse Abstracts (Clearinghouse) were created to provide access to essential treatability information by U.S. Environmental Protection Agency (EPA) personnel and other interested parties. Under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, preference is to be given to treatment alternatives that permanently reduce the volume, toxicity, or mobility of the hazardous waste. The Clearinghouse initiative provides access to some initial treatability studies that have been conducted at hazardous waste sites.

These initial studies were those collected to aid in the development of treatment methods for excavated soils which would trigger the Land Disposal Restrictions (LDRs) under the 1984 Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA). The studies presented contain treatability data on various technologies for soil and debris. Alternatives are being considered by the Office of Emergency and Remedial Response (OERR) to collect additional treatability studies and expand the scope of the Clearinghouse to include a more complete coverage of different media, technologies, contaminants, and report sources.

This document is designed for use by the EPA and other interested parties involved in hazardous waste site remediation projects. The abstracts are presented in a standard format and are indexed to assist the User in locating the studies deemed to be relevant to their site-specific problem. The copies of the treatability study source reports are contained in the EPA Librarys' Hazardous Waste Collection. A cognizant contact is listed on each abstract to provide the User with an additional information source to learn more about each study. Some quality assurance limitations exist for these reports, and the information presented may not be appropriate for all uses. The User must determine the appropriateness of each abstract and each treatability study sources report on a case-by case basis.

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Camp Dresser & McKee of Fairfax, Virginia prepared and collected the treatability study reports (Contract 69-01-6939). The CDM project manager was William Koski.

Chapter 1

Introduction and Background

The Comprehensive Environmental Response Compensation and Liability Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 authorizes the U.S. Environmental Protection Agency (EPA) to identify, investigate, and remediate abandoned hazardous waste sites in this country. SARA identifies a preference to utilize alternatives that use treatment as a principal element. Treatment technologies that should be utilized are those that permanently reduce the volume, toxicity, or mobility of the hazardous waste.

The EPA realizes that access to accurate and pertinent information is essential to the acceptance of these treatment technologies. The valuable work which has been done in this area must be compiled in a usable fashion so that the work on future sites can build on this existing information. A Clearinghouse for this purpose has been established to make information available to the Agency and other interested parties.

The Superfund Treatability Clearinghouse is designed to facilitate communication among EPA Regional offices and their contractors regarding the types of treatability studies conducted to date and the performance of the various technologies. This document contains abstracts of a limited number of treatability studies performed to date. The treatability study source reports are available in the EPA library's Hazardous Waste Collection. This compilation of treatability study abstracts allows the user to quickly screen all abstracted documents to identify the most promising studies for their individual site-specific application. Then the source reports can be reviewed for more specific information taking into consideration the appropriateness of applying the information to the User's specific site.

The 1984 Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA) prohibit continued land disposal of untreated hazardous wastes and require EPA to develop treatment standards that must be met before disposal of contaminated soil from Superfund sites is allowed. The EPA Office of Emergency and Remedial Response (OERR) contracted CDM Federal Programs Corporation to assist the Agency in fulfilling these obligations. An extensive soil treatment data collection effort was conducted throughout 1987 and 1988. The results from several hundred previously conducted studies were collected and reviewed. These initial abstracts are from those studies which focused on treatment methods for excavated soils.

The results of this intensive data collection and evaluation effort are contained in "Summary of Treatment Technology Effectiveness for Contaminated Soil, March 1989" (Technical Report EPA/540/2-89/). This summary report contains a quantitative comparison of the effectiveness of different technologies on various groups of contaminants. Using the available treatability study data, removal efficiencies were computed for each of these technologies and ranked according to their effectiveness on each group of contaminants. The summary report presents effective treatment technologies for each contaminant group and provides a general description of the technologies. This summary report may also be used as a reference in developing a treatability variance for the Land Disposal Restrictions.

By comparison, the Superfund Treatability Clearinghouse provides additional specific design and operational information for each of the technologies by making available the treatability source reports. Although not necessary, the User may use the information contained in the Clearinghouse in conjunction with the summary report previously described to identify treatment technology categories which warrant further site-specific investigation.

1.1 Scope

The treatability study source reports that were abstracted are documents obtained from various sources including EPA Superfund removal and remedial activities; EPA Office of Research and Development (OR&D) tests; Department of Defense and Department of Energy studies; state programs; private party studies; and vendor demonstrations. The studies vary in completeness and technical quality. The source reports range from short papers to lengthy multi-volume reports on full-scale test results.

The treatability studies abstracted cover a wide variety of test conditions. The studies include National Priorities List (NPL) and non-NPL sites and encompass bench, pilot, and full-scale studies. The majority of the Clearinghouse treatability study reports contain site-specific treatability information; however, several examples are related to manufactured soils as well. More than one abstract will appear for any report that presents analytical results for more than one technology. Currently, the Superfund Treatability

Clearinghouse is focused on soil and sludge, but eventually it will be expanded to include other media (surface water and ground water). It is necessary to recognize that some of these treatment technologies are still under development and the effectiveness of the technologies on variable waste concentrations, combinations of contaminants, and differing soil characteristics is not fully documented.

There will be a continuing effort by EPA to collect results from additional treatability studies and expand the field of technologies, contaminants, and media covered by the Clearinghouse. The SITE program, OR&D research, and RCRA/CERCLA investigations and remediations are areas which will yield additional studies applicable to this effort.

1.2 Development

The Superfund Treatability Clearinghouse was developed in response to the need to facilitate communication regarding treatability information for the remediation of hazardous waste sites. This EPA OERR initiative is the first step to develop a clearinghouse of treatability studies. Over the past two years, a large number of treatability documents were collected, evaluated, and screened so that preliminary conclusions could be drawn regarding the effectiveness of the various technologies on commonly occurring classes of contaminated soils. Information from these reports was used to develop the "Summary of Treatment Technology Effectiveness for Contaminated Soils", referenced previously. The screened set of documents, providing quantitative treatment results from this group of reports, was used for this Superfund Treatability Clearinghouse report. This currently available information is presented as received, without independent validation, to facilitate timely technology transfer. Due to the developmental status of some of the technologies, the reproducibility of the results cannot be ensured. However, a User who has a thorough knowledge of their specific site conditions, can select treatment technology categories which warrant further site-specific investigation.

The Superfund Treatability Clearinghouse Abstracts were developed to capture information that would be most useful to a User with a site-specific hazardous waste problem. Each abstract is identified by a unique Document Number, which can be used to locate the abstract within this report and to locate the treatability study source report in the EPA library's Hazardous Waste Collection. The first section of the abstract contains data on the treatment process, the document reference, a cognizant contact, and selected site-specific information from the document. The text includes a background summary, operational information, and performance results based on conclusions documented in the treatability report. The results and conclusions are not necessarily those of the EPA. Information is then provided on the site-specific contaminants. If a concise table of performance data was available in the study, this table was also included. An advisory statement regarding quality assurance of the data appears with each abstract.

The key elements of interest to the User are the contaminants to be treated and the treatment technology. For a small number of studies, there is insufficient information on a specific technology or contaminant to assist the User. Thus technologies and contaminants have been grouped to identify a larger set of studies that may be of interest. This contaminant grouping is consistent with the regulatory development of Land Disposal Restrictions for soils and debris by the Office of Solid Waste. The chemical compounds were classified into one of thirteen treatability groups:

- Halogenated non polar aromatics (W01)
- PCBs, halogenated dioxins, furans, and their precursors (W02)
- Halogenated phenols, cresols, amines, thiols, and other polar aromatics (W03)
- Halogenated aliphatic compounds (W04)
- Halogenated cyclic aliphatics, ethers, esters, and ketones (W05)
- Nitrated aromatic and aliphatic compounds (W06)
- Heterocyclics and simple non-halogenated aromatics (W07)
- Polynuclear aromatics (W08)
- Other polar non-halogenated organic compounds (W09)
- Non-volatile metals (W10)
- Volatile metals (W11)
- Other inorganics (W12)
- Other organics (W13)

The many discrete treatment technologies were classified into four technology groups:

- Thermal treatment
- Physical/chemical treatment
- Biological treatment
- Immobilization

The ability of the User to screen all studies, which have been made available in the EPA libraries, and to identify a cognizant contact will allow appropriate follow-up to identify promising technologies for the User's application. By building on this past experience, technologies that reduce the volume, toxicity, or mobility of the hazardous waste will be encouraged and more widely used.

1.3 Intended Users

The intended Users are primarily project managers from EPA, contractors, or other parties, with a site-specific hazardous waste problem to remediate. This Clearinghouse provides an information source useful during the Remedial Investigation/Feasibility Study (RI/FS) and early Remedial Design (RD) phases. The information can assist in technology selection, data development to support the technology evaluation, and design of additional treatability studies.

1.4 Treatability Clearinghouse Update

OERR is considering alternatives and mechanisms for updates to the Treatability Clearinghouse. It is envisioned that the Clearinghouse information would be updated periodically. Additional treatability studies would be abstracted and abstract changes would be implemented as information is received and resources allow.

Plans are underway to load the abstract information into the OSWER Solid and Hazardous Waste Technology Transfer Electronic Bulletin Board. This mechanism will allow more flexible access and updating. Mr. Jim Cummings from EPA's Office of Program Management Technology (202-382-4686, FTS) can be contacted for further information on access to the Bulletin Board and progress on including this treatability information.

1.5 Limitations

This compilation of treatability abstracts does not encompass all known treatability studies conducted to date. It does not include all OR&D studies, any in-situ studies, or all media capable of being treated. The media covered in this report are limited to soil and sludge. Other study sources, both site-specific and general, such as EPA OR&D, should be consulted as appropriate. EPA's intent is to progressively expand the Clearinghouse coverage to include ground water and surface water treatability studies.

Each of the treatability studies reviewed for the Superfund Treatability Clearinghouse project was conducted for a different purpose and in response to different requirements. As a result, the treatment data in the reports may have several of the following limitations.

- Treatment data were unavailable for some contaminants.
- Some treatment technologies were only tested at laboratory/bench or pilot scales, thereby limiting the applicability of data.
- The untreated and treated soils from a particular test were sometimes analyzed using different analytical procedures.
- The degradation products from waste destruction technologies were seldom identified or quantified, preventing a complete evaluation of the technologies' effectiveness.
- Some treatment technologies transfer contaminants from one medium to another; these cross media impacts were not always quantified.
- Different analytical protocols were used to generate treatment data for different tests. These various protocols may not yield comparable results.
- Quality assurance/quality control (QA/QC) procedures used for field sampling and laboratory analysis were inconsistently reported, and few studies were independently validated or reviewed, limiting the reliability of the data.

Many of these treatment technologies are still under development, and the effectiveness of the technologies on variable waste concentrations, combinations of contaminants, and in the presence of various soil characteristics is only partially documented. Because the average removal efficiencies presented herein are based on highly variable data, and are subject to a great deal of uncertainty, caution should be utilized in selecting technologies for further evaluation.

The level of QA/QC reported in each treatability study source report is indicated in the Operational Information section of each abstract. As noted above, there are many limitations to the quality and quantity of the available data. For this reason, a note "Quality assurance of data may not be appropriate for all uses" appears on each page to advise the User to make an independent determination as to the applicability and appropriateness of the data for the purposes intended.

1.6 Organization of the Report

This report describes the format and the contents of the Superfund Treatability Clearinghouse and presents recommendations for the use of this information. Chapter 2 contains a more detailed description of the abstract format. Chapter 3 provides the methodology for using the Clearinghouse Abstracts and associated treatability study source reports. An index to the abstracts is provided in Chapter 3. The abstracts themselves are included in Chapter 4 in alphabetical order by the unique Document Number. The treatability study source reports are available in the EPA library's Hazardous Waste Collection, also sorted in alphabetical order by the unique Document Number.

Chapter 2

Framework of the Treatability Clearinghouse

The Superfund Treatability Clearinghouse was designed for use by the project personnel or reviewers of remedial investigation/feasibility studies and remedial design studies. The Treatability Abstracts have been designed to provide the information necessary for the User to identify the potentially applicable studies and to determine whether each study is of further interest with respect to a site-specific project. Once an applicable study is identified, the treatability study source report can be found in the EPA library's Hazardous Waste Collection, using the unique Document Number listed on the abstract. A cognizant contact is also listed on the abstract, who may be able to provide additional or updated information on the treatability study.

The standard format of the abstract is provided in Table 2.1. There are both text and fixed format fields. Information from the treatability reports is used to complete the abstract fields. The fixed format information was selected to enable indexing of the information in various ways. The text provides an overview of the document and, where possible, specific information of interest to remedial project personnel.

Each element of the abstract format presented in Table 1 is discussed below:

Treatment Process: The standard format of this information is Technology Group-Process Description. It was recognized that this would be one of the data elements of primary interest which could be used as a sort criterion. Table 2.2 lists the process descriptions for each of the technology groups - biological, immobilization, physical/chemical, and thermal. It should be noted that technologies where thermal energy is used to change the phase of the contaminant (low temperature thermal stripping) have been included in the physical/chemical technology group. The process descriptions listed on the abstracts are those reported in the treatability report. If there is more than one technology, with sufficient information to be abstracted within a treatability report, a separate abstract was created to characterize each technology.

Media: The standard format of this information is: Medium/Description of medium. Medium is one of the choices from the list contained in Table 2.3. A description of the medium is included to characterize the type of medium tested. In the case of soil, the description relates to the soil matrix.

Document Reference: The Document Reference is in a standard format as follows: author; title of document; who the report was prepared for; the number of pages in the document; and the document date. This reference appears on the cover sheet of the treatability study.

Document Type: There is considerable variability in the scope and size of documents. To assist the User in evaluating the treatability study, the document type is identified on the abstract. Table 2.3 lists the various document types contained in the Clearinghouse.

Contact: The Contact is, in general, the person from which the treatability report was received who is knowledgeable about that study. The format is as follows: name; organization; address; and telephone number. This contact is listed to allow follow-up or consultation on the study.

Site Name: The format of this information is the Name of the site and category of the site. The name of the site is that which it is commonly referred to. A list of site categories is contained in Table 2.3.

Location of Test: This information indicates where the test was conducted. This is not always apparent because many of the tests are not conducted at the site where the test samples were taken.

Background: This text describes the treatability study document and what type of information it contains. It also identifies the purpose in conducting the treatability tests.

Operational Information: This text describes test parameters such as the scale of the test (bench, pilot, or full-scale test); the quantity of test materials; the contaminants; the soil matrix, if applicable; and other key operational information related to the study.

Performance: This text reports the results of the tests and key findings or conclusions reached by the study's authors. This can include failures as well as successes. Cost effectiveness is discussed if it was reported.

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Contaminants: This section provides information about the contaminants reported on in the study. The contaminants are identified by Chemical Abstract Service (CAS) number to facilitate data input and concise identification. The contaminants are further grouped into contaminant groups or treatability groups. This grouping is the same as the treatability grouping used by the Office of Solid Waste for regulatory development of the Land Disposal Restrictions (U.S. EPA, OSW, 1988). The grouping assists in the evaluation of treatability results for contaminants that possess similar physical and chemical characteristics. The definition of these groups is found in Appendix A. Each group is identified by a code number for purposes of managing this data, e.g., W01.

The thirteen treatability groups and the respective compounds within each are presented in Table 3.1. Further, the compounds are listed in alphabetical order in Table 3.2. These tables are designed to assist the User in identifying the correct contaminant group for a site-specific compound.

Table: In the instance where a one-page table captured a major part of the performance information in a study, be it treatability or cost, the table was included as part of the abstract. These tables were selectively included in the abstracts to add to the performance information available to the User.

MM/YY-#: This note at the bottom right hand corner is the month and year the abstract was created and the file number. This note indicates when the abstract was last updated.

Document Number: XXXX-X: This unique 4-letter code located in the bottom right hand corner was assigned to the abstract and the corresponding treatability study source report to facilitate identification. Using this unique number, an abstract can be identified in the Clearinghouse document and the treatability source report can be identified in the EPA library's Hazardous Waste Collection. If more than one technology is abstracted from a single document, an additional number is assigned at the end of the Document Number.

NOTE: The note "Quality assurance of data may not be appropriate for all uses." is on the bottom of all abstract pages to remind the User that the information is of variable quality. It is the responsibility of the User to determine if the information is suitable for the site-specific purpose.

Table 2.1. Format of Superfund Treatability Clearinghouse Abstract

Treatment Process:	**Technology Group - Process Description**
Media:	Media/Description
Document Reference:	Author, title, organization prepared for, number of pages, date
Document Type:	Type
Contact:	Name, organization, address, telephone number
Site Name:	Name (site category)
Location of Test:	Location

BACKGROUND: (General overview of the treatability study document)

OPERATIONAL INFORMATION: (Operational details of study, QA/QC)

PERFORMANCE: (Performance data and information)

CONTAMINANTS:
Analytical data is (or is not) provided in the treatability study report.

Treatability Group	CAS Number	Contaminants
WXX - Group name	Number	Name

(Selected summary table from report)

NOTE: Quality assurance of data may not be appropriate for all uses.

MM/YY-#
Document Number: XXXX-X

Table 2.2. Technology Groups and Treatment Processes Contained in the Superfund Treatability Clearinghouse

Technology Group	Process Description
Biological	Biological
	Aerobic
	Anaerobic
	Combined Biological
	Composting
Thermal	Incineration
	Rotary Kiln
	Liquid Injection
	Fluidized Bed Combustion
	Infrared
	Plasma Arc
	Critical Water Oxidation
	Wet Air Oxidation
	Phrolysis
	Circulating Bed Combust
	Aqueous Thermal Decomp
	Vitrification
	Hearth Incineration
	Molten Glass Incineration
	Molten Salt Incineration
Immobilization	Immobilization
	Sorption
	Stabilization
	Microencapsulation
	Cement Solidification
	Flyash Solidification
	Carbonate Immobilization
	In-Situ Solidification
Physical/Chemical	Physical/Chemical
	Reduction/Oxidation
	Neutralization
	Dechlorination
	Hydrolysis
	Air Stripping/Steam Stripping
	Vacuum ExtractionDistillation
	Activiated Carbon Adsorp
	Evaporation
	Soil Washing/Filtration
	Phase Separation
	Chemical Extraction Precipitation
	Electrodialysis
	Electrochemical
	Soil Gas Vapor Extraction
	Chelation and Extraction
	Ion Exchange Resin
	Mechanical Aeration
	Plastic Media Blasting
	In-Situ Soil Air Stripping
	Magnetic Separation
	Drying,Active
	Drying, Ambient Air
	Blow/Compressor Aeration
	Dehalogenation
	Alkaline Destruction/Aque
	Low Temp Stripping
	Thermal Desop/UV Photolysis
	RF/Microwave In-Situ

Table 2.3. Abstract Data Lists

Media	Document Type	Site Category
Water	EPA OR&D Report	NPL
Sludge	Memo	NPL (Federal facility)
Soil	Conference Paper	Non-NPL
Debris	Journal Paper	Non-NPL (Federal facility)
Liquid waste	Contractor/VendorTreatability Study	Unspecified
Solid waste	Other Treatability Report	
Air		
Other		

Chapter 3

Methodology for Using the Treatability Clearinghouse Abstracts

This document, with its compilation of abstracts, is designed to be used with the treatability study source reports. To assist the User in finding the abstracts of possible interest for review, two indices have been developed. The indices are presented in Tables 3.3 and 3.4. The indices list the Treatment Category, Treatment Process, Contaminant Groups/Codes, Media, Test Scale, and Document Number for each treatability ategory, and finally by treatment process. report. Table 3.3 presents an index sorted first by treatment category followed by treatment process, with a third-level sort by contaminant group. Table 3.4 presents an index sorted first by contaminant group, then by treatment Before using these indices, the User will have to determine the contaminant group/code to which their specific contaminant of interest belongs, using Table 3.2.

The Document Number on the indices (Tables 3.3 & 3.4) enables the User to identify particular abstracts from the compilation of Treatability Clearinghouse Abstracts (Chapter 4). In Chapter 4, the abstracts are presented in alphabetical order by Document Number. When the documents of interest are identified, the source reports can be found in the EPA library's Hazardous Waste Collection arranged in alphabetical order by Document Number under the title Superfund Treatability Clearinghouse Abstracts.

3.1 Examples of How to Utilize the Indices

Two scenarios are provided demonstrating the use of the indices; one for each of the approaches discussed above.

Case 1 - A remedial project manager (RPM) is responsible for cleaning up a site containing soils contaminated with lead, and he needs to determine the type of technologies that would be appropriate to remediate the site. The RPM must first determine the contaminant group in which lead is a member. To accomplish this, Table 3.2 is used (Reference List for Contaminant Group Identification, Sorted by Chemical Name). The specific chemical contaminants are listed alphabetically by chemical names. Lead appears in the contaminant group entitled Volatile Metals. The Index of Treatability Study Abstracts by Contaminant Groups, Table 3.4, is then utilized to identify what abstracts are associated with the treatment of volatile metals. Seventeen records are identified that are associated with treating volatile metals.

The treatability processes identified involve immobilization, physical/chemical, and thermal treatment categories. Upon review of the abstracts relating to volatile metals (Chapter 4.0), it is determined that six abstracts deal specifically with the treatability of lead. These abstracts include soil washing and immobilization technologies. The other abstracts deal with different metals and the incineration of mixtures of metals and organic compounds. Cost, performance data, and site characteristics are provided in the abstracts. The related studies can be reviewed in the EPA library's Hazardous Waste Collection. Also, the identified contacts may be able to provide additional information.

Case 2 - Another RPM is responsible for cleaning up a site containing dioxin, and he wants to consider utilizing dechlorinating agents to accomplish the cleanup. Dechlorination is located on Table 3.3 (Index of Treatability Study Abstracts by Treatment) under the Physical/ Chemical Treatment Category, and five abstracts dealing with dechlorination of dioxin contaminated sludges and soils are listed. The abstracts are EUZD, FBZZ-1, FCFR-6, FCLC, and EUTV. It should be noted that the abstracts may address one or all of the contaminants in the contaminant group. For this scenario, dioxins, furans, and PCBs are the elements of contaminant group W02. These five abstracts can then be reviewed to obtain information on treatment performance, costs, site conditions, etc. Further detailed information can be obtained by reviewing the source reports or talking to the cognizant contacts.

TABLE 3.1. Reference List for Contaminant Group Identification Sorted by Contaminant Groups

W01 - HALOGENATED NON-POLAR AROMATIC COMPOUNDS

Chemical Name	CAS Number*
1,2,4,5-TETRACHLOROBENZENE	95-94-3
1,2,4-TRICHLOROBENZENE	120-82-1
1,2-DICHLOROBENZENE	95-50-1
1,3-DICHLOROBENZENE	541-73-1
1,4-DICHLOROBENZENE	106-46-7
2-CHLORONAPHTHALENE	91-58-7
4,4'-DDD	72-54-8
4,4'-DDE	72-55-9
4,4'-DDT	50-29-3
BENZYL CHLORIDE	100-44-7
CHLOROBENZENE	108-90-7
CHLOROBENZILATE	570-15-6
HEXACHLOROBENZENE	118-74-1
PENTACHLOROBENZENE	608-93-5
TOTAL CHLOROBENZENES	T108-90-7
TOTAL TRICHLOROBENZENES	TOT-TCB

W02 - DIOXINS/FURANS/PCBS & THEIR PRECURSORS

Chemical Name	CAS Number*
1,2,3,4-TETRACHLORODIBENZO-P-DIOXIN	30746-58-8
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	1746-01-6
2,3,7,8-TETRACHLORODIBENZOFURAN	F1746-01-6
2,4,5-TRICHLOROPHENOXYACETIC ACID	93-76-5
2,4-DICHLOROPHENOXYACETIC ACID (2,4-D)	94-75-7
2-(2,4,5-TRICHLOROPHENOXY)PROPIONIC ACID	93-72-1
DECACHLOROBIPHENYLS	JPCB
DICHLOROBIPHENYLS	BPCB
HEPTACHLOROBIPHENYLS	GPCB
HEPTACHLORODIBENZODIOXINS	HEPCDD
HEPTACHLORODIBENZOFURANS	HEPCDF
HEXACHLOROBIPHENYLS	FPCB
HEXACHLORODIBENZODIOXINS	HEXCDD
HEXACHLORODIBENZOFURANS	HEXCDF
MONOCHLOROBIPHENYL	APCB
NONACHLOROBIPHENYLS	IPCB
OCTACHLOROBIPHENYLS	HPCB
OCTACHLORODIBENZODIOXINS	OCDD
OCTACHLORODIBENZOFURANS	OCDF
PCB-1016	12674-11-2
PCB-1221	11104-28-2
PCB-1232	11141-16-5
PCB-1242	53469-21-9
PCB-1248	12672-29-6
PCB-1254	11097-69-1
PCB-1260	11096-82-5
PENTACHLOROBIPHENYLS	EPCB
PENTACHLORODIBENZODIOXINS	PCDD
PENTACHLORODIBENZOFURANS	PCDF
TETRACHLOROBIPHENYLS	DPCB
TETRACHLORODIBENZODIOXINS	TCDD
TETRACHLORODIBENZOFURANS	TCDF
TOTAL DIOXINS AND FURANS	TOT-DF
TOTAL FURANS	TOT-FUR
TOTAL PCB'S	1336-36-3
TRICHLOROBIPHENYLS	CPCB

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*CAS number: Chemical Abstract Service Number assigned to uniquely identify a compound. 3/89

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TABLE 3.1. (Continued)

W03 - HAL PHENOLS, CRESOLS, ETHERS, & THIOLS

Chemical Name	CAS Number*
2,3,4,6-TETRACHLOROPHENOL	58-90-2
2,4,5-TRICHLOROPHENOL	95-95-4
2,4,6-TRICHLOROPHENOL	88-06-2
2,4-DICHLOROPHENOL	120-83-2
2,6-DICHLOROPHENOL	87-65-0
2-CHLOROPHENOL	95-57-8
3,3'-DICHLOROBENZIDINE	91-94-1
3,4-DICHLOROPHENOL	34DCP
4-BROMOPHENYL PHENYL ETHER	101-55-3
4-CHLORO-3-METHYLPHENOL	59-50-7
4-CHLOROANILINE	106-47-8
4-CHLOROPHENYL PHENYL ETHER	7005-72-3
METHOXYCHLOR	72-43-5
P-CHLOROBENZENESULFONIC ACID	PCBSA
P-CHLOROPHENYLMETHYL SULFIDE	CPMS
P-CHLOROPHENYLMETHYL SULFONE	CPMSO2
P-CHLOROPHENYLMETHYL SULFOXIDE	CPMSO
PENTACHLOROPHENOL	87-86-5
SUPONA	470-90-6

W04 - HALOGENATED ALIPHATIC COMPOUNDS

Chemical Name	CAS Number*
1,1,1,2-TETRACHLOROETHANE	630-20-6
1,1,1-TRICHLOROETHANE	71-55-6
1,1,2,2-TETRACHLOROETHANE	79-34-5
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	76-13-1
1,1,2-TRICHLOROETHANE	79-00-5
1,1-DICHLOROETHANE	75-34-3
1,1-DICHLOROETHENE	75-35-4
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8
1,2-DICHLOROETHANE	107-06-2
1,2-DICHLOROPROPANE	78-87-5
2-CHLORO-1,3-BUTADIENE	126-99-8
BROMODICHLOROMETHANE	75-27-4
BROMOFORM	75-25-2
BROMOMETHANE (METHYL BROMIDE)	74-83-9
CARBON TETRACHLORIDE	56-23-5
CHLOROETHANE	75-00-3
CHLOROFORM	67-66-3
CHLOROMETHANE (METHYL CHLORIDE)	74-87-3
CIS-1,2-DICHLOROETHENE	156-59-2
CIS-1,3-DICHLOROPROPENE	10061-01-5
DIBROMOCHLOROMETHANE	124-48-1
DICHLORODIFLUOROMETHANE	75-71-8
ETHYLENE DIBROMIDE	106-93-4
HEXACHLOROBUTADIENE	87-68-3
HEXACHLOROETHANE	67-72-1
METHYLENE CHLORIDE (DICHLOROMETHANE)	75-09-2
PENTACHLOROETHANE	76-01-7
TETRACHLOROETHENE	127-18-4
TRANS-1,2-DICHLOROETHENE	156-60-5
TRANS-1,3-DICHLOROPROPENE	10061-02-6
TRICHLOROETHENE	79-01-6
TRICHLOROFLUOROMETHANE	75-69-4
VINYL CHLORIDE	75-01-4

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*CAS Number: Chemical Abstract Service Number assigned to uniquely identify a compound. 3/89

TABLE 3.1. (Continued)

W05 - HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES

Chemical Name	CAS Number*
2-CHLOROETHYL VINYL ETHER	110-75-8
3-CHLOROPROPIONITRILE	542-76-7
ALDRIN	309-00-2
ALPHA-BHC	319-84-6
BETA-BHC	319-85-7
BIS(2-CHLOROETHOXY) METHANE	111-91-1
BIS(2-CHLOROETHYL) ETHER	111-44-4
BIS(2-CHLOROISOPROPYL) ETHER	39638-32-9
CHLORDANE	57-74-9
CHLOROMETHYL METHYL ETHER	542-88-1
DELTA-BHC	319-86-8
DIELDRIN	60-57-1
ENDOSULFAN I	959-98-8
ENDOSULFAN II	33213-65-9
ENDOSULFAN SULFATE	1031-07
ENDRIN	72-20-8
ENDRIN ALDEHYDE	7421-93-4
ENDRIN KETONE	53494-70-5
EPICHLOROHYDRIN	106-89-8
GAMMA-BHC (LINDANE)	58-89-9
HEPTACHLOR	76-44-8
HEPTACHLOR EPOXIDE	1024-57-3
HEXACHLOROCYCLOPENTADIENE	77-47-4
HEXACHLORONORBORNADIENE	3389-71-7
ISODRIN	465-73-6
OCTACHLOROCYCLOPENTENE	706-78-5
TOXAPHENE	8001-35-2

W06 - NITRATED AROMATIC & ALIPHATIC COMPOUNDS

Chemical Name	CAS Number*
1,3,5-TRINITROHEXAHYDRO-1,3,5-TRIAZINE	121-82-4
2,4-DINITROPHENOL	51-28-5
2,4-DINITROTOLUENE	121-14-2
2,6-DINITROTOLUENE	606-20-2
2-AMINO-4,6-DINITROTOLUENE	T99-55-8
2-METHYL-4,6-DINITROPHENOL	534-52-1
2-NITROANILINE	88-74-4
2-NITROPHENOL	88-75-5
3-NITROANILINE	99-09-2
4-NITROANILINE	100-01-6
4-NITROPHENOL	100-02-7
DINITROBENZENE	25154-54-5
ETHYL PARATHION	56-38-2
HMX	135-HMX
METHYL PARATHION	298-00-0
NITROBENZENE	98-95-3
NITROCELLULOSE	9004-70-0
PENTACHLORONITROBENZENE	82-68-8
TRINITROBENZENE	99-35-4
TRINITROPHENLYMETHYLNITRAMINE (TETRYL)	479-45-8
TRINITROTOLUENE (TNT)	118-96-7

W07 - HETEROCYCLICS & SIMPLE NON-HAL AROMATICS

Chemical Name	CAS Number*
1-ETHYL-2-METHYL-BENZENE	611-14-3
ALKYL BENZENE	ABC
AROMATIC HYDROCARBONS	TOT-AR
BENZENE	71-43-2
BENZENE, TOLUENE, ETHYLBENZENE, XYLENES	BTEX
ETHYLBENZENE	100-41-4
ISOPROPYLBENZENE	98-82-8
M-XYLENE	108-38-3
O&P XYLENE	95-47-6
O-XYLENE	97-47-6
P-XYLENE	106-42-3
PYRIDINE	110-86-1
STYRENE	100-42-5
TOLUENE	108-88-3
XYLENES (TOTAL)	1330-20-7

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*CAS Number: Chemical Abstract Service Number assigned to uniquely identify a compound. 3/89

TABLE 3.1. (Continued)

W08 - POLYNUCLEAR AROMATICS

Chemical Name	CAS Number*
1-METHYLNAPHTHALENE	90-12-0
2-METHYLNAPHTHALENE	91-57-6
ACENAPHTHENE	83-32-9
ACENAPHTHYLENE	208-96-8
ANTHRACENE	120-12-7
BENZO(A)ANTHRACENE	56-55-3
BENZO(A)PYRENE	50-32-8
BENZO(B)FLUORANTHENE	205-99-2
BENZO(G,H,I)PERYLENE	191-24-2
BENZO(K)FLUORANTHENE	207-08-9
BIPHENYL	92-52-4
CHRYSENE	218-01-9
DIBENZO(A,H)ANTHRACENE	53-70-3
DIBENZOFURAN	132-64-9
FLUORANTHENE	206-44-0
FLUORENE	86-73-7
INDENO(1,2,3-CD)PYRENE	193-39-5
NAPHTHALENE	91-20-3
PHENANTHRENE	85-01-8
PYRENE	129-00-0
TOTAL POLYCYCLIC AROMATIC HYDROCARBONS	TOT-PAH

W09 - OTHER POLAR ORGANIC COMPOUNDS

Chemical Name	CAS Number*
1,2-BENZENEDICARBOXYLIC ACID	117-82-8
1,2-DIPHENYLHYDRAZINE	122-66-7
1,4 DIOXANE	123-91-1
1-PROPANOL	71-23-8
2,4-DIMETHYLPHENOL	105-67-9
2-BUTANONE	78-93-3
2-ETHOXYETHANOL	110-80-5
2-HEPTANONE	110-43-0
2-HEXANONE	591-78-6
2-METHYLPHENOL	95-48-7
3-METHYL PHENOL	108-39-4
4-HYDROXY-4-METHYL-2-PENTANONE	123-42-2
4-METHYL-2-PENTANONE	108-10-1
4-METHYL-3-PENTEN-2-ONE	141-79-7
4-METHYL-4-PENTEN-2-ONE	3744-02-3

W09 - OTHER POLAR ORGANIC COMPOUNDS (continued)

Chemical Name	CAS Number*
4-METHYLPHENOL	106-44-5
5-METHYL-2-HEXANONE	110-12-3
ACETONE	67-64-1
ACETONITRILE	75-05-8
ACETOPHENONE	98-86-2
ACROLEIN	107-02-8
ACRYLONITRILE	107-37-1
ALLYL ALCOHOL	107-18-6
ANILINE	62-53-3
BENZIDINE	92-87-5
BENZOIC ACID	65-85-0
BENZOIC ACID, DIHYDROXY	T119-36-8
BENZYL ALCOHOL	100-51-6
BIS(2-ETHYLHEXYL) PHTHALATE	117-81-7
BUTYLBENZYL PHTHALATE	85-68-7
CARBON DISULFIDE	75-15-0
CRESOLS	1319-77-3
CYCLOHEXANONE	108-94-1
DI-N-BUTYL PHTHALATE	84-74-2
DI-N-OCTYL PHTHALATE	117-84-0
DIETHYL PHTHALATE	84-66-2
DIMETHOXYETHANE	110-71-4
DIMETHYL PHTHALATE	131-11-3
DIPHENYLAMINE	122-39-4
ETHANOL,2-ETHOXY ACETATE	111-15-9
ETHOXYETHYLENE	109-92-2
ETHYL ACETATE	141-78-6
ETHYLENE OXIDE	75-21-8
HEXADECANOIC ACID	57-10-3
HEXANEDIOIC ACID, DIOCTYL ESTER	123-79-5
ISOBUTANOL	78-83-1
ISOPHORONE	78-59-1
METHANOL	67-56-1
METHYL METHACRYLATE	80-62-6
N-NITROSODI-N-PROPYLAMINE	621-64-7
N-NITROSODIMETHYLAMINE	62-75-9
ORGANIC CYANIDE	C57-12-5
PHENOL	108-95-2
PROPANOIC ACID,2-METHYL	74381-40-1
TRIETHYLAMINE	121-44-8
VINYL ACETATE	108-05-4

*CAS Number: Chemical Abstract Service Number assigned to uniquely identify a compound.

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TABLE 3.1. (Continued)

W10 - NON-VOLATILE METALS

Chemical Name	CAS Number*
ALUMINUM	7429-90-5
BARIUM	7440-39-3
BERYLLIUM	7440-41-7
CALCIUM	7440-70-2
CHROMIUM	7440-47-3
CHROMIUM (HEXAVALENT)	18540-29-9
COBALT	7440-48-4
COPPER	7440-50-8
IRON	7439-89-6
LITHIUM	7439-93-2
MAGNESIUM	7439-95-4
MANGANESE	7439-96-5
MOLYBDENUM	7439-98-7
NICKEL	7440-02-0
POTASSIUM	7440-09-7
SODIUM	7440-23-5
STRONTIUM	7440-24-6
VANADIUM	7440-62-2

W11 - VOLATILE METALS

Chemical Name	CAS Number*
ANTIMONY	7440-36-0
ARSENIC	7440-38-2
CADMIUM	7440-43-9
LEAD	7439-92-1
MERCURY	7439-97-6
SELENIUM	7782-49-2
SILVER	7440-22-4
THALLIUM	7440-28-0
TIN	7440-31-5
TITANIUM	7440-32-6
ZINC	7440-66-6

*CAS Number: Chemical Abstract Service Number assigned to uniquely identify a compound. 3/89

W12 - OTHER INORGANICS

Chemical Name	CAS Number*
AMMONIA AS NITROGEN	N7664-41-7
ASBESTOS (FIBROUS)	01332-21-4
BORON	7440-42-8
CARBON MONOXIDE	XCOX
CHEMICAL OXYGEN DEMAND	COD
CHLORIDE	CHLORIDE
CYANIDE	57-12-5
DESTRUCTION REMOVAL EFFICIENCY	XDRE-%
FLUORIDE	16984-48-8
HCI EMMISSIONS KG/HR	X7647-01-0
HYDRAZINE	302-01-2
HYDROCYANIC ACID	74-90-8
NITRATE AS N	NO3
OXIDES OF NITROGEN	XNOX
PARTICULATE EMISSIONS G/DSCF	XPART-A
PARTICULATE EMISSIONS MG/DSCM	XPART
pH	XPH
PHOSPHATE	PO4
PHOSPHORUS	7723-14-0
SILICON	7440-21-3
SULFATE	SULFATE
SULFIDE	A57-12-5
THALLIUM SULFATE	10031-59-1
URANIUM	7440-61-1
YITRIUM	10361-92-9

TABLE 3.2. Reference List for Contaminant Group Identification Sorted by Chemical Name

Chemical Name	Contaminant Groups/Codes	CAS Number*
1,1,1,2-TETRACHLOROETHANE	W04 HALOGENATED ALIPHATIC COMPOUNDS	630-20-6
1,1,1-TRICHLOROETHANE	W04 HALOGENATED ALIPHATIC COMPOUNDS	71-55-6
1,1,2,2-TETRACHLOROETHANE	W04 HALOGENATED ALIPHATIC COMPOUNDS	79-34-5
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	W04 HALOGENATED ALIPHATIC COMPOUNDS	76-13-1
1,1,2-TRICHLOROETHANE	W04 HALOGENATED ALIPHATIC COMPOUNDS	79-00-5
1,1-DICHLOROETHANE	W04 HALOGENATED ALIPHATIC COMPOUNDS	75-34-3
1,1-DICHLOROETHENE	W04 HALOGENATED ALIPHATIC COMPOUNDS	75-35-4
1,2,3,4-TETRACHLORODIBENZO-P-DIOXIN	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	30746-58-8
1,2,4,5-TETRACHLOROBENZENE	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	95-94-3
1,2,4-TRICHLOROBENZENE	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	120-82-1
1,2-BENZENEDICARBOXYLIC ACID	W09 OTHER POLAR ORGANIC COMPOUNDS	117-82-8
1,2-DIBROMO-3-CHLOROPROPANE	W04 HALOGENATED ALIPHATIC COMPOUNDS	96-12-8
1,2-DICHLOROBENZENE	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	95-50-1
1,2-DICHLOROETHANE	W04 HALOGENATED ALIPHATIC COMPOUNDS	107-06-2
1,2-DICHLOROPROPANE	W04 HALOGENATED ALIPHATIC COMPOUNDS	78-87-5
1,2-DIPHENYLHYDRAZINE	W09 OTHER POLAR ORGANIC COMPOUNDS	122-66-7
1,3,5-TRINITROHEXAHYDRO-1,3,5-TRIAZINE	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	121-82-4
1,3-DICHLOROBENZENE	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	541-73-1
1,4 DIOXANE	W09 OTHER POLAR ORGANIC COMPOUNDS	123-91-1
1,4-DICHLOROBENZENE	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	106-46-7
1-ETHYL-2-METHYL-BENZENE	W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	611-14-3
1-METHYLNAPHTHALENE	W08 POLYNUCLEAR AROMATICS	90-12-0
1-METHYLPHENANTHRENE	W13 OTHER ORGANICS	1-MP
1-PENTENE-3-OL	W13 OTHER ORGANICS	616-25-1
1-PROPANOL	W09 OTHER POLAR ORGANIC COMPOUNDS	71-23-8
2 METHYL PROPANE	W13 OTHER ORGANICS	75-28-5
2(3H)FURANONE,DIHYDRO	W13 OTHER ORGANICS	96-48-0
2(5H)-FURANONE, 5,5-DIMETHYL	W13 OTHER ORGANICS	20019-64-1
2,3,4 TRIMETHYL HEXANE	W13 OTHER ORGANICS	921-47-1
2,3,4,6-TETRACHLOROPHENOL	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	58-90-2
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	1746-01-6
2,3,7,8-TETRACHLORODIBENZOFURAN	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	F1746-01-6
2,3-DIMETHYL HEPTANE	W13 OTHER ORGANICS	3074-71-3
2,4,5-TRICHLOROPHENOL	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	95-95-4
2,4,5-TRICHLOROPHENOXYACETIC ACID	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	93-76-5
2,4,6-TRICHLOROPHENOL	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	88-06-2
2,4-DICHLOROPHENOL	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	120-83-2
2,4-DICHLOROPHENOXYACETIC ACID (2,4-D)	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	94-75-7
2,4-DIMETHYL HEPTANE	W13 OTHER ORGANICS	2213-23-2
2,4-DIMETHYLPHENOL	W09 OTHER POLAR ORGANIC COMPOUNDS	105-67-9
2,4-DINITROPHENOL	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	51-28-5
2,4-DINITROTOLUENE	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	121-14-2
2,5-DIMETHYL HEPTANE	W13 OTHER ORGANICS	2216-30-0
2,6,10,14 TETRAMETHYL HEXADECANE	W13 OTHER ORGANICS	638-36-8
2,6,10,14 TETRAMETHYL PENTADECANE	W13 OTHER ORGANICS	1921-70-6
2,6-DICHLOROPHENOL	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	87-65-0
2,6-DINITROTOLUENE	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	606-20-2
2-(2,4,5-TRICHLOROPHENOXY)PR OPIONIC ACID	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	93-72-1
2-AMINO-4,6-DINITROTOLUENE	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	T99-55-8

*CAS Number: Chemical Abstract Service Number assigned to uniquely identify a compound.

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TABLE 3.2. (Continued)

Chemical Name	Contaminant Groups/Codes	CAS Number*
2-BUTANONE	W09 OTHER POLAR ORGANIC COMPOUNDS	78-93-3
2-CHLORO-1,3-BUTADIENE	W04 HALOGENATED ALIPHATIC COMPOUNDS	126-99-8
2-CHLOROETHANOL PHOSPHATE	W13 OTHER ORGANICS	115-96-8
2-CHLOROETHYL VINYL ETHER	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	110-75-8
2-CHLORONAPHTHALENE	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	91-58-7
2-CHLOROPHENOL	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	95-57-8
2-ETHOXYETHANOL	W09 OTHER POLAR ORGANIC COMPOUNDS	110-80-5
2-HEPTANONE	W09 OTHER POLAR ORGANIC COMPOUNDS	110-43-0
2-HEXANONE	W09 OTHER POLAR ORGANIC COMPOUNDS	591-78-6
2-METHYL-4,6-DINITROPHENOL	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	534-52-1
2-METHYLNAPHTHALENE	W08 POLYNUCLEAR AROMATICS	91-57-6
2-METHYLPHENOL	W09 OTHER POLAR ORGANIC COMPOUNDS	95-48-7
2-NITROANILINE	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	88-74-4
2-NITROPHENOL	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	88-75-5
3 HEXON-2-ONE-5-METHYL	W13 OTHER ORGANICS	5166-53-0
3,3'-DICHLOROBENZIDINE	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	91-94-1
3,3-DIMETHYL HEXANE	W13 OTHER ORGANICS	563-16-6
3,4-DICHLOROPHENOL	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	34DCP
3,5-DIMETHYL HEPTANE	W13 OTHER ORGANICS	926-82-9
3-CHLOROPROPIONITRILE	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	542-76-7
3-METHYL OCTANE	W13 OTHER ORGANICS	2216-33-3
3-METHYL PHENOL	W09 OTHER POLAR ORGANIC COMPOUNDS	108-39-4
3-NITROANILINE	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	99-09-2
4 PENTIN 2-ONE	W13 OTHER ORGANICS	13891-87-7
4,4'-DDD	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	72-54-8
4,4'-DDE	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	72-55-9
4,4'-DDT	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	50-29-3
4-BROMOPHENYL PHENYL ETHER	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	101-55-3
4-CHLORO-3-METHYLPHENOL	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	59-50-7
4-CHLOROANILINE	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	106-47-8
4-CHLOROPHENYL PHENYL ETHER	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	7005-72-3
4-HYDROXY-4-METHYL-2-PENTANONE	W09 OTHER POLAR ORGANIC COMPOUNDS	123-42-2
4-METHYL OCTANE	W13 OTHER ORGANICS	2216-34-4
4-METHYL-2-PENTANONE	W09 OTHER POLAR ORGANIC COMPOUNDS	108-10-1
4-METHYL-3-PENTEN-2-ONE	W09 OTHER POLAR ORGANIC COMPOUNDS	141-79-7
4-METHYL-4-PENTEN-2-ONE	W09 OTHER POLAR ORGANIC COMPOUNDS	3744-02-3
4-METHYLPHENOL	W09 OTHER POLAR ORGANIC COMPOUNDS	106-44-5
4-NITROANILINE	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	100-01-6
4-NITROPHENOL	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	100-02-7
4-PENTEN-2-ONE	W13 OTHER ORGANICS	1389-18-7
4H-1,2,4 TRIAZALE, 4 METHYL	W13 OTHER ORGANICS	1057-00-8
5-METHYL-2-HEXANONE	W09 OTHER POLAR ORGANIC COMPOUNDS	110-12-3
7,12-DIMETHYLBENZ (A)ANTHRACENE	W13 OTHER ORGANICS	57-97-6
9,9'-DICHLOROFLUORENE	W13 OTHER ORGANICS	C86-73-7
ACENAPHTHENE	W08 POLYNUCLEAR AROMATICS	83-32-9
ACENAPHTHYLENE	W08 POLYNUCLEAR AROMATICS	208-96-8
ACETONE	W09 OTHER POLAR ORGANIC COMPOUNDS	67-64-1

*CAS Number: Chemical Abstract Service Number assigned to uniquely identify a compound. 3/89

TABLE 3.2. (Continued)

Chemical Name	Contaminant Groups/Codes	CAS Number*
ACETONITRILE	W09 OTHER POLAR ORGANIC COMPOUNDS	75-05-8
ACETOPHENONE	W09 OTHER POLAR ORGANIC COMPOUNDS	98-86-2
ACROLEIN	W09 OTHER POLAR ORGANIC COMPOUNDS	107-02-8
ACRYLONITRILE	W09 OTHER POLAR ORGANIC COMPOUNDS	107-37-1
ALDRIN	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	309-00-2
ALK20	W13 OTHER ORGANICS	ALK20
ALKANE (19.71)	W13 OTHER ORGANICS	ALK19
ALKANE (25.02)	W13 OTHER ORGANICS	ALK25
ALKANE (27.81)	W13 OTHER ORGANICS	ALK27
ALKYL BENZENE	W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	ABC
ALLYL ALCOHOL	W09 OTHER POLAR ORGANIC COMPOUNDS	107-18-6
ALPHA-BHC	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	319-84-6
ALUMINUM	W10 NON-VOLATILE METALS	7429-90-5
AMMONIA AS NITROGEN	W12 OTHER INORGANICS	N7664-41-7
ANILINE	W09 OTHER POLAR ORGANIC COMPOUNDS	62-53-3
ANTHRACENE	W08 POLYNUCLEAR AROMATICS	120-12-7
ANTIMONY	W11 VOLATILE METALS	7440-36-0
AROMATIC HYDROCARBONS	W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	TOT-AR
ARSENIC	W11 VOLATILE METALS	7440-38-2
ASBESTOS (FIBROUS)	W12 OTHER INORGANICS	01332-21-4
AZULENE,7-ETHYL-1,4-DEMETHYL	W13 OTHER ORGANICS	1529-05-5
BARIUM	W10 NON-VOLATILE METALS	7440-39-3
BENZAMIDE,2-HYDROXY-N-PHENYL	W13 OTHER ORGANICS	87-17-2
BENZENE	W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	71-43-2
BENZENE, TOLUENE,ETHYLBENZENE, XYLENES	W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	BTEX
BENZIDINE	W09 OTHER POLAR ORGANIC COMPOUNDS	92-87-5
BENZO(A)ANTHRACENE	W08 POLYNUCLEAR AROMATICS	56-55-3
BENZO(A)PYRENE	W08 POLYNUCLEAR AROMATICS	50-32-8
BENZO(B)FLUORANTHENE	W08 POLYNUCLEAR AROMATICS	205-99-2
BENZO(G,H,I)PERYLENE	W08 POLYNUCLEAR AROMATICS	191-24-2
BENZO(K)FLUORANTHENE	W08 POLYNUCLEAR AROMATICS	207-08-9
BENZOIC ACID	W09 OTHER POLAR ORGANIC COMPOUNDS	65-85-0
BENZOIC ACID, DIHYDROXY	W09 OTHER POLAR ORGANIC COMPOUNDS	T119-36-8
BENZYL ALCOHOL	W09 OTHER POLAR ORGANIC COMPOUNDS	100-51-6
BENZYL CHLORIDE	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	100-44-7
BERYLLIUM	W10 NON-VOLATILE METALS	7440-41-7
BETA-BHC	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	319-85-7
BIPHENYL	W08 POLYNUCLEAR AROMATICS	92-52-4
BIS(2-CHLOROETHOXY) METHANE	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	111-91-1
BIS(2-CHLOROETHYL) ETHER	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	111-44-4
BIS(2-CHLOROISOPROPYL) ETHER	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	39638-32-9
BIS(2-ETHYLHEXYL) PHTHALATE	W09 OTHER POLAR ORGANIC COMPOUNDS	117-81-7
BORON	W12 OTHER INORGANICS	7440-42-8
BROMODICHLOROMETHANE	W04 HALOGENATED ALIPHATIC COMPOUNDS	75-27-4
BROMOFORM	W04 HALOGENATED ALIPHATIC COMPOUNDS	75-25-2
BROMOMETHANE (METHYL BROMIDE)	W04 HALOGENATED ALIPHATIC COMPOUNDS	74-83-9
BUTYLBENZYL PHTHALATE	W09 OTHER POLAR ORGANIC COMPOUNDS	85-68-7
C10 AROMATIC (9.7-11.5)	W13 OTHER ORGANICS	C10AR97
C7 ALIPHATIC (20.68)	W13 OTHER ORGANICS	C7AL

*CAS Number: Chemical Abstract Service Number assigned to uniquely identify a compound.

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TABLE 3.2. (Continued)

Chemical Name	Contaminant Groups/Codes	CAS Number*
C9 AROMATIC (37.54)	W13 OTHER ORGANICS	C9AR37
C9 AROMATIC (7.6-9.0)	W13 OTHER ORGANICS	C9AR76
CADMIUM	W11 VOLATILE METALS	7440-43-9
CALCIUM	W10 NON-VOLATILE METALS	7440-70-2
CAPTAN	W13 OTHER ORGANICS	133-06-2
CARBAZOLE (9-AZAFLUORENE)	W13 OTHER ORGANICS	A86-73-7
CARBON DISULFIDE	W09 OTHER POLAR ORGANIC COMPOUNDS	75-15-0
CARBON MONOXIDE	W12 OTHER INORGANICS	XCOX
CARBON TETRACHLORIDE	W04 HALOGENATED ALIPHATIC COMPOUNDS	56-23-5
CHEMICAL OXYGEN DEMAND	W12 OTHER INORGANICS	COD
CHLORDANE	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	57-74-9
CHLORIDE	W12 OTHER INORGANICS	CHLORIDE
CHLOROBENZENE	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	108-90-7
CHLOROBENZILATE	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	570-15-6
CHLOROETHANE	W04 HALOGENATED ALIPHATIC COMPOUNDS	75-00-3
CHLOROFORM	W04 HALOGENATED ALIPHATIC COMPOUNDS	67-66-3
CHLOROMETHANE (METHYL CHLORIDE)	W04 HALOGENATED ALIPHATIC COMPOUNDS	74-87-3
CHLOROMETHYL METHYL ETHER	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	542-88-1
CHLOROPHENESIC ACID	W13 OTHER ORGANICS	CPEA
CHLOROPHENIC ACID	W13 OTHER ORGANICS	CPA
CHROMIUM	W10 NON-VOLATILE METALS	7440-47-3
CHROMIUM (HEXAVALENT)	W10 NON-VOLATILE METALS	18540-29-9
CHRYSENE	W08 POLYNUCLEAR AROMATICS	218-01-9
CIS-1,2-DICHLOROETHENE	W04 HALOGENATED ALIPHATIC COMPOUNDS	156-59-2
CIS-1,3-DICHLOROPROPENE	W04 HALOGENATED ALIPHATIC COMPOUNDS	10061-01-5
COBALT	W10 NON-VOLATILE METALS	7440-48-4
COPPER	W10 NON-VOLATILE METALS	7440-50-8
CRESOLS	W09 OTHER POLAR ORGANIC COMPOUNDS	1319-77-3
CRUDE OIL	W13 OTHER ORGANICS	CRUDE
CYANIDE	W12 OTHER INORGANICS	57-12-5
CYCLOHEXANONE	W09 OTHER POLAR ORGANIC COMPOUNDS	108-94-1
DECACHLOROBIPHENYLS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	JPCB
DECENE	W13 OTHER ORGANICS	19699-18-0
DELTA-BHC	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	319-86-8
DESTRUCTION REMOVAL EFFICIENCY	W12 OTHER INORGANICS	XDRE-%
DI-N-BUTYL PHTHALATE	W09 OTHER POLAR ORGANIC COMPOUNDS	84-74-2
DI-N-OCTYL PHTHALATE	W09 OTHER POLAR ORGANIC COMPOUNDS	117-84-0
DIAZINON	W13 OTHER ORGANICS	333-41-5
DIBENZ (A,H) ACRIDINE	W13 OTHER ORGANICS	226-36-8
DIBENZO(A,H)ANTHRACENE	W08 POLYNUCLEAR AROMATICS	53-70-3
DIBENZOFURAN	W08 POLYNUCLEAR AROMATICS	132-64-9
DIBROMOCHLOROMETHANE	W04 HALOGENATED ALIPHATIC COMPOUNDS	124-48-1
DICHLOROBIPHENYLS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	BPCB
DICHLORODIFLUOROMETHANE	W04 HALOGENATED ALIPHATIC COMPOUNDS	75-71-8
DICYCLOPENTADIENE	W13 OTHER ORGANICS	77-73-6
DIELDRIN	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	60-57-1
DIESEL FUEL, OIL, PETROL	W13 OTHER ORGANICS	DIESEL
DIETHYL PHTHALATE	W09 OTHER POLAR ORGANIC COMPOUNDS	84-66-2
DIMETHOXYETHANE	W09 OTHER POLAR ORGANIC COMPOUNDS	110-71-4

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TABLE 3.2. (Continued)

Chemical Name	Contaminant Groups/Codes	CAS Number*
DIMETHYL TEREPHTHALATE	W13 OTHER ORGANICS	A131-11-3
DIMETHYLNAPHTHALENE	W13 OTHER ORGANICS	DMN
DINITROBENZENE	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	25154-54-5
DIPHENYLAMINE	W09 OTHER POLAR ORGANIC COMPOUNDS	122-39-4
EICOSANE	W13 OTHER ORGANICS	112-95-8
ENDOSULFAN I	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	959-98-8
ENDOSULFAN II	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	33213-65-9
ENDOSULFAN SULFATE	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	1031-07-8
ENDRIN	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	72-20-8
ENDRIN ALDEHYDE	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	7421-93-4
ENDRIN KETONE	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	53494-70-5
EPICHLOROHYDRIN	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	106-89-8
ETHANOL,2-ETHOXY ACETATE	W09 OTHER POLAR ORGANIC COMPOUNDS	111-15-9
ETHOXYETHYLENE	W09 OTHER POLAR ORGANIC COMPOUNDS	109-92-2
ETHYL ACETATE	W09 OTHER POLAR ORGANIC COMPOUNDS	141-78-6
ETHYL PARATHION	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	56-38-2
ETHYLBENZENE	W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	100-41-4
ETHYLENE DIBROMIDE	W04 HALOGENATED ALIPHATIC COMPOUNDS	106-93-4
ETHYLENE OXIDE	W09 OTHER POLAR ORGANIC COMPOUNDS	75-21-8
FLUORANTHENE	W08 POLYNUCLEAR AROMATICS	206-44-0
FLUORENE	W08 POLYNUCLEAR AROMATICS	86-73-7
FLUORIDE	W12 OTHER INORGANICS	16984-48-8
GAMMA-BHC (LINDANE)	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	58-89-9
GLYPHOSATE	W13 OTHER ORGANICS	GLY
HCI EMMISSIONS KG/HR	W12 OTHER INORGANICS	X7647-01-0
HEPTACHLOR	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	76-44-8
HEPTACHLOR EPOXIDE	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	1024-57-3
HEPTACHLOROBIPHENYLS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	GPCB
HEPTACHLORODIBENZODIOXINS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	HEPCDD
HEPTACHLORODIBENZOFURANS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	HEPCDF
HEPTADECANE	W13 OTHER ORGANICS	629-78-7
HEPTANE	W13 OTHER ORGANICS	142-82-5
HEXACHLOROBENZENE	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	118-74-1
HEXACHLOROBIPHENYLS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	FPCB
HEXACHLOROBUTADIENE	W04 HALOGENATED ALIPHATIC COMPOUNDS	87-68-3
HEXACHLOROCYCLOPENTADIENE	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	77-47-4
HEXACHLORODIBENZODIOXINS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	HEXCDD
HEXACHLORODIBENZOFURANS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	HEXCDF
HEXACHLOROETHANE	W04 HALOGENATED ALIPHATIC COMPOUNDS	67-72-1
HEXACHLORONORBORNADIENE	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	3389-71-7
HEXADECANE	W13 OTHER ORGANICS	544-76-3
HEXADECANOIC ACID	W09 OTHER POLAR ORGANIC COMPOUNDS	57-10-3
HEXANE	W13 OTHER ORGANICS	110-54-3
HEXANEDIOIC ACID, DIOCTYL ESTER	W09 OTHER POLAR ORGANIC COMPOUNDS	123-79-5
HMX	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	135-HMX
HYDRAZINE	W12 OTHER INORGANICS	302-01-2
HYDROCYANIC ACID	W12 OTHER INORGANICS	74-90-8
INDENO(1,2,3-CD)PYRENE	W08 POLYNUCLEAR AROMATICS	193-39-5
IRON	W10 NON-VOLATILE METALS	7439-89-6
ISOBUTANOL	W09 OTHER POLAR ORGANIC COMPOUNDS	78-83-1

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TABLE 3.2. (Continued)

Chemical Name	Contaminant Groups/Codes	CAS Number*
ISODRIN	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	465-73-6
ISOPHORONE	W09 OTHER POLAR ORGANIC COMPOUNDS	78-59-1
ISOPROPYLBENZENE	W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	98-82-8
LEAD	W11 VOLATILE METALS	7439-92-1
LITHIUM	W10 NON-VOLATILE METALS	7439-93-2
M-XYLENE	W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	108-38-3
MAGNESIUM	W10 NON-VOLATILE METALS	7439-95-4
MALATHION	W13 OTHER ORGANICS	121-75-5
MANGANESE	W10 NON-VOLATILE METALS	7439-96-5
MERCURY	W11 VOLATILE METALS	7439-97-6
METHANOL	W09 OTHER POLAR ORGANIC COMPOUNDS	67-56-1
METHOXYCHLOR	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	72-43-5
METHYL METHACRYLATE	W09 OTHER POLAR ORGANIC COMPOUNDS	80-62-6
METHYL PARATHION	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	298-00-0
METHYLCYCLOPENTANE	W13 OTHER ORGANICS	96-37-7
METHYLENE CHLORIDE (DICHLOROMETHANE)	W04 HALOGENATED ALIPHATIC COMPOUNDS	75-09-2
MINERAL OIL	W13 OTHER ORGANICS	8020-83-5
MOLYBDENUM	W10 NON-VOLATILE METALS	7439-98-7
MONOCHLOROBIPHENYL	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	APCB
N-NITROSODI-N-PROPYLAMINE	W09 OTHER POLAR ORGANIC COMPOUNDS	621-64-7
N-NITROSODIMETHYLAMINE	W09 OTHER POLAR ORGANIC COMPOUNDS	62-75-9
N-NITROSODIPHENYLAMINE	W09 OTHER POLAR ORGANIC COMPOUNDS	86-30-6
NAPHTHALENE	W08 POLYNUCLEAR AROMATICS	91-20-3
NICKEL	W10 NON-VOLATILE METALS	7440-02-0
NITRATE AS N	W12 OTHER INORGANICS	NO3
NITROBENZENE	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	98-95-3
NITROCELLULOSE	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	9004-70-0
NONACHLOROBIPHENYLS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	IPCB
NONANE	W13 OTHER ORGANICS	111-84-2
O&P XYLENE	W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	95-47-6
O-XYLENE	W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	97-47-6
OCTACHLOROBIPHENYLS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	HPCB
OCTACHLOROCYCLOPENTENE	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	706-78-5
OCTACHLORODIBENZODIOXINS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	OCDD
OCTACHLORODIBENZOFURANS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	OCDF
OCTADECANE	W13 OTHER ORGANICS	593-45-3
OIL AND GREASE	W13 OTHER ORGANICS	TOT-OIL
ORGANIC CYANIDE	W09 OTHER POLAR ORGANIC COMPOUNDS	C57-12-5
OTHER VOLATILE ORGANIC COMPOUNDS	W13 OTHER ORGANICS	OTH-VOC
OXIDES OF NITROGEN	W12 OTHER INORGANICS	XNOX
P-CHLOROBENZENESULFONIC ACID	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	PCBSA
P-CHLOROPHENYLMETHYL SULFIDE	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	CPMS
P-CHLOROPHENYLMETHYL SULFONE	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	CPMSO2
P-CHLOROPHENYLMETHYL SULFOXIDE	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	CPMSO
P-XYLENE	W07 HETEROCYCLICS & SIMPLE NON-HAL	106-42-3
PARTICULATE EMISSIONS G/DSCF	W12 OTHER INORGANICS	XPART-A
PARTICULATE EMISSIONS MG/DSCM	W12 OTHER INORGANICS	XPART
PCB-1016	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	12674-11-2
PCB-1221	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	11104-28-2

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TABLE 3.2. (Continued)

Chemical Name	Contaminant Groups/Codes	CAS Number*
PCB-1232	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	11141-16-5
PCB-1242	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	53469-21-9
PCB-1248	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	12672-29-6
PCB-1254	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	11097-69-1
PCB-1260	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	11096-82-5
PENTACHLOROBENZENE	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	608-93-5
PENTACHLOROBIPHENYLS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	EPCB
PENTACHLORODIBENZODIOXINS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	PCDD
PENTACHLORODIBENZOFURANS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	PCDF
PENTACHLOROETHANE	W04 HALOGENATED ALIPHATIC COMPOUNDS	76-01-7
PENTACHLORONITROBENZENE	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	82-68-8
PENTACHLOROPHENOL	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	87-86-5
PENTADECANE	W13 OTHER ORGANICS	629-62-9
PENTANE	W13 OTHER ORGANICS	109-66-0
pH	W12 OTHER INORGANICS	XPH
PHENANTHRENE	W08 POLYNUCLEAR AROMATICS	85-01-8
PHENOL	W09 OTHER POLAR ORGANIC COMPOUNDS	108-95-2
PHENOLIC COMPOUNDS	W13 OTHER ORGANICS	PHEN
PHORATE	W13 OTHER ORGANICS	298-02-2
PHOSPHATE	W12 OTHER INORGANICS	PO4
PHOSPHORUS	W12 OTHER INORGANICS	7723-14-0
POTASSIUM	W10 NON-VOLATILE METALS	7440-09-7
PRONAMIDE	W13 OTHER ORGANICS	23950-58-5
PROPANOIC ACID,2-METHYL	W09 OTHER POLAR ORGANIC COMPOUNDS	74381-40-1
PYRENE	W08 POLYNUCLEAR AROMATICS	129-00-0
PYRIDINE	W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	110-86-1
SELENIUM	W11 VOLATILE METALS	7782-49-2
SILICON	W12 OTHER INORGANICS	7440-21-3
SILVER	W11 VOLATILE METALS	7440-22-4
SODIUM	W10 NON-VOLATILE METALS	7440-23-5
STRONTIUM	W10 NON-VOLATILE METALS	7440-24-6
STYRENE	W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	100-42-5
SULFATE	W12 OTHER INORGANICS	SULFATE
SULFIDE	W12 OTHER INORGANICS	A57-12-5
SUPONA	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	470-90-6
TETRACHLOROBIPHENYLS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	DPCB
TETRACHLORODIBENZODIOXINS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	TCDD
TETRACHLORODIBENZOFURANS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	TCDF
TETRACHLOROETHENE	W04 HALOGENATED ALIPHATIC COMPOUNDS	127-18-4
TETRACOSANE HEXAMETHYL	W13 OTHER ORGANICS	111-01-3
THALLIUM	W11 VOLATILE METALS	7440-28-0
THALLIUM SULFATE	W12 OTHER INORGANICS	10031-59-1
TIN	W11 VOLATILE METALS	7440-31-5
TITANIUM	W11 VOLATILE METALS	7440-32-6
TOLUENE	W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	108-88-3
TOTAL CHLOROBENZENES	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	T108-90-7
TOTAL DIOXINS AND FURANS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	TOT-DF
TOTAL EXTRACTABLE HYDROCARBONS	W13 OTHER ORGANICS	TEH
TOTAL FURANS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	TOT-FUR

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TABLE 3.2. (Continued)

Chemical Name	Contaminant Groups/Codes	CAS Number*
TOTAL HYDROCARBONS	W13 OTHER ORGANICS	THC
TOTAL ORGANIC CARBON	W13 OTHER ORGANICS	TOC
TOTAL ORGANIC HALOGENS	W13 OTHER ORGANICS	TOX
TOTAL PCB'S	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	1336-36-3
TOTAL PETROLEUM HYDROCARBONS	W13 OTHER ORGANICS	TOT-PETROL
TOTAL POLYCYCLIC AROMATIC HYDROCARBONS	W08 POLYNUCLEAR AROMATICS	TOT-PAH
TOTAL TRICHLOROBENZENES	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	TOT-TCB
TOTAL VOLATILE ORGANICS	W13 OTHER ORGANICS	TOT-VOC
TOXAPHENE	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	8001-35-2
TRANS-1,2-DICHLOROETHENE	W04 HALOGENATED ALIPHATIC COMPOUNDS	156-60-5
TRANS-1,3-DICHLOROPROPENE	W04 HALOGENATED ALIPHATIC COMPOUNDS	10061-02-6
TRICHLOROBIPHENYLS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	CPCB
TRICHLOROETHENE	W04 HALOGENATED ALIPHATIC COMPOUNDS	79-01-6
TRICHLOROFLUOROMETHANE	W04 HALOGENATED ALIPHATIC COMPOUNDS	75-69-4
TRIETHYLAMINE	W09 OTHER POLAR ORGANIC COMPOUNDS	121-44-8
TRIMETHYLNAPHTHALENE	W13 OTHER ORGANICS	TMN
TRINITROBENZENE	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	99-35-4
TRINITROPHENLYMETHYLNITRAMINE (TETRYL)	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	479-45-8
TRINITROTOLUENE (TNT)	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	118-96-7
URANIUM	W12 OTHER INORGANICS	7440-61-1
VANADIUM	W10 NON-VOLATILE METALS	7440-62-2
VINYL ACETATE	W09 OTHER POLAR ORGANIC COMPOUNDS	108-05-4
VINYL CHLORIDE	W04 HALOGENATED ALIPHATIC COMPOUNDS	75-01-4
XYLENES (TOTAL)	W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	1330-20-7
YITRIUM	W12 OTHER INORGANICS	10361-92-9
ZINC	W11 VOLATILE METALS	7440-66-6

*CAS Number: Chemical Abstract Service Number assigned to uniquely identify a compound. 3/89

TABLE 3.3. Index of Treatability Study Abstracts by Treatment

Treatment Category	Treatment Process	Contaminant Groups/Codes	Media	Scale	Document Number
BIOLOGICAL	BIOLOGICAL	W09 OTHER POLAR ORGANIC COMPOUNDS	SOIL/GENERIC	PILOT	EURK
	BIOLOGICAL	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	SOIL/GENERIC	PILOT	EWGC
		W08 POLYNUCLEAR AROMATICS			
		W13 OTHER ORGANICS			
	AEROBIC	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	EZUU
	AEROBIC	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	PILOT	EZZA
		W04 HALOGENATED ALIPHATIC COMPOUNDS			
		W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS			
		W08 POLYNUCLEAR AROMATICS			
		W09 OTHER POLAR ORGANIC COMPOUNDS			
	AEROBIC	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SLUDGE/-OTHER	PILOT	FCQP
	ANAEROBIC	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	EZUU
	COMPOSTING	W08 POLYNUCLEAR AROMATICS	SOIL/SANDY	BENCH	EUQX
	COMPOSTING	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	SOIL/LAGOON SED	PILOT	EURS
	COMPOSTING	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	SOIL/SANDY	PILOT	EURT
IMMOBILIZATION	STABILIZATION	W11 VOLATILE METALS	SOIL/CLAYEY	BENCH	EURY
	STABILIZATION	W10 NON-VOLATILE METALS	SOIL/GENERIC	BENCH	FCAK
		W11 VOLATILE METALS			
	CEMENT SOLIDIFICATION	W10 NON-VOLATILE METALS	SOIL/GENERIC	BENCH	EUXT
		W11 VOLATILE METALS			
	CEMENT SOLIDIFICATION	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	FHMF
		W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS			
		W04 HALOGENATED ALIPHATIC COMPOUNDS			
		W08 POLYNUCLEAR AROMATICS			
		W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS			
		W08 POLYNUCLEAR AROMATICS			
		W09 OTHER POLAR ORGANIC COMPOUNDS			
		W10 NON-VOLATILE METALS			
		W11 VOLATILE METALS			
	FLYASH SOLIDIFICATION	W11 VOLATILE METALS	SOIL/CLAYEY	BENCH	EURY
	FLYASH SOLIDIFICATION	W10 NON-VOLATILE METALS	SLUDGE/-METAL FNSH	PILOT	FAAP
		W11 VOLATILE METALS			
		W12 OTHER INORGANICS			
	FLYASH SOLIDIFICATION	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	FHMF
		W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS			
		W04 HALOGENATED ALIPHATIC COMPOUNDS			
		W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS			
		W08 POLYNUCLEAR AROMATICS			

TABLE 3.3. (Continued)

Treatment Category	Treatment Process	Contaminant Groups/Codes	Media	Scale	Document Number
IMMOBILIZATION	FLYASH SOLIDIFICATION	W09 OTHER POLAR ORGANIC COMPOUNDS	SOIL/GENERIC	BENCH	FHMF
		W10 NON-VOLATILE METALS			
		W11 VOLATILE METALS			
	CARBONATE IMMOBILIZATION	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	FHMF
		W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS			
		W04 HALOGENATED ALIPHATIC COMPOUNDS			
		W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS			
		W08 POLYNUCLEAR AROMATICS			
		W09 OTHER POLAR ORGANIC COMPOUNDS			
		W10 NON-VOLATILE METALS			
		W11 VOLATILE METALS			
PHYSICAL/-CHEMICAL	REDUCTION/-OXIDATION	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	FULL	EWFZ
		W04 HALOGENATED ALIPHATIC COMPOUNDS			
		W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS			
		W11 VOLATILE METALS			
		W13 OTHER ORGANICS			
	DECHLORINATION	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	PILOT	EUZD
	DECHLORINATION	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	BENCH	FBZZ-1
	DECHLORINATION	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	BENCH	FCFR-6
	DECHLORINATION	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SLUDGE/OTHER	BENCH	FCLC
	DECHLORINATION	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	EUTV
		W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS			
		W04 HALOGENATED ALIPHATIC COMPOUNDS			
		W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS			
		W08 POLYNUCLEAR AROMATICS			
		W09 OTHER POLAR ORGANIC COMPOUNDS			
		W10 NON-VOLATILE METALS			
		W11 VOLATILE METALS			
	SOIL WASHING	W08 POLYNUCLEAR AROMATICS	SOIL/SILTY	FULL	EUTT
		W11 VOLATILE METALS			
		W12 OTHER INORGANICS			
		W13 OTHER ORGANICS			
	SOIL WASHING	W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/ROCKS	FULL	EUTT
		W08 POLYNUCLEAR AROMATICS			
		W13 OTHER ORGANICS			
	SOIL WASHING	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/SANDY	BENCH	EUZU
		W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS			
	SOIL WASHING	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/SANDY	FULL	EVAR
		W08 POLYNUCLEAR AROMATICS			
		W09 OTHER POLAR ORGANIC COMPOUNDS			
		W13 OTHER ORGANICS			
	SOIL WASHING	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/SANDY	BENCH	FRET
	SOIL WASHING	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	EUQW
		W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS			

TABLE 3.3. (Continued)

Treatment Category	Treatment Process	Contaminant Groups/Codes	Media	Scale	Document Number
PHYSICAL/-CHEMICAL	SOIL WASHING	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/GENERIC	BENCH	EUQW
		W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS			
		W08 POLYNUCLEAR AROMATICS			
		W09 OTHER POLAR ORGANIC COMPOUNDS			
		W10 NON-VOLATILE METALS			
		W11 VOLATILE METALS			
	CHEMICAL EXTRACTION	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	SOIL/LAGOON SED	BENCH	EURU
	LOW TEMP STRIPPING	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/SILTY	PILOT	EUQS
		W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS			
		W13 OTHER ORGANICS			
	LOW TEMP STRIPPING	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	FULL	EXPE
		W04 HALOGENATED ALIPHATIC COMPOUNDS			
		W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS			
		W08 POLYNUCLEAR AROMATICS			
		W09 OTHER POLAR ORGANIC COMPOUNDS			
		W13 OTHER ORGANICS			
	LOW TEMP STRIPPING	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/GENERIC	BENCH	FCMK
		W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS			
		W13 OTHER ORGANICS			
	LOW TEMP STRIPPING	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/SANDY	PILOT	FCSF
		W04 HALOGENATED ALIPHATIC COMPOUNDS			
		W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS			
	LOW TEMP STRIPPING	W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SLUDGE/OILY	PILOT	FCSP-1
		W08 POLYNUCLEAR AROMATICS			
		W09 OTHER POLAR ORGANIC COMPOUNDS			
	LOW TEMP STRIPPING	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	EZYQ
		W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS			
	LOW TEMP STRIPPING	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/GENERIC	BENCH	EZYQ
		W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS			
		W08 POLYNUCLEAR AROMATICS			
		W09 OTHER POLAR ORGANIC COMPOUNDS			
		W10 NON-VOLATILE METALS			
		W11 VOLATILE METALS			
	THERMAL DESOP/UV PHOTOLYS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	PILOT	EWGE
THERMAL	INCINERATION	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	SOIL/LAGOON SED	BENCH	EUWW1
		W10 NON-VOLATILE METALS			
		W11 VOLATILE METALS			
		W12 OTHER INORGANICS			

TABLE 3.3. (Continued)

Treatment Category	Treatment Process	Contaminant Groups/Codes	Media	Scale	Document Number
THERMAL	INCINERATION	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	BENCH	EZYN
		W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES			
		W08 POLYNUCLEAR AROMATICS			
		W09 OTHER POLAR ORGANIC COMPOUNDS			
		W10 NON-VOLATILE METALS			
		W11 VOLATILE METALS			
	INCINERATION	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	FDBP
		W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS			
		W04 HALOGENATED ALIPHATIC COMPOUNDS			
		W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES			
		W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS			
		W09 OTHER POLAR ORGANIC COMPOUNDS			
		W13 OTHER ORGANICS			
	ROTARY KILN	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	SOIL/GENERIC	PILOT	EURP
	ROTARY KILN	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/SANDY	FULL	EUZH
		W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS			
	ROTARY KILN	W04 HALOGENATED ALIPHATIC COMPOUNDS	SLUDGE/OILY	PILOT	EXPC
		W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS			
		W10 NON-VOLATILE METALS			
		W11 VOLATILE METALS			
		W13 OTHER ORGANICS			
	ROTARY KILN	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	PILOT	EZUY
		W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES			
	ROTARY KILN	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	PILOT	EUZM
		W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS			
		W04 HALOGENATED ALIPHATIC COMPOUNDS			
		W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS			
		W08 POLYNUCLEAR AROMATICS			
		W09 OTHER POLAR ORGANIC COMPOUNDS			
		W10 NON-VOLATILE METALS			
		W11 VOLATILE METALS			
	INFRARED	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	PILOT	EUTR
	INFRARED	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	PILOT	EWQD
		W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS			
	INFRARED	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/CLAYEY	PILOT	EZZB
		W04 HALOGENATED ALIPHATIC COMPOUNDS			
		W07 HETEROCYCLICS & SIMPLE NON-HAL AROMATICS			
		W08 POLYNUCLEAR AROMATICS			
		W09 OTHER POLAR ORGANIC COMPOUNDS			
	INFRARED	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SLUDGE/OTHER	PILOT	EZZC
	CRITICAL WATER OXIDATION	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/WATER-WAY SED	BENCH	FBZZ-2
	PYROLYSIS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/SANDY	PILOT	EXPD
	PYROLYSIS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	PILOT	FCFR-4

TABLE 3.3. (Continued)

Treatment Category	Treatment Process	Contaminant Groups/Codes	Media	Scale	Document Number
THERMAL	CIRCULATING BED COMBUST.	W01 HALOGENATED NON-POLAR AROMATIC COMPOUNDS W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	PILOT	EUXM
	CIRCULATING BED COMBUST.	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/CLAYEY	PILOT	EWHC
	CIRCULATING BED COMBUST.	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	PILOT	FCFR-3

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Table 3.4. Index of Treatability Study Abstracts by Contaminant Groups (W01 Halogenated Non-Polar Aromatic Compounds)

Treatment Category	Treatment Process	Contaminant Groups/Codes		Media	Scale	Document Number
BIOLOGICAL	AEROBIC	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	EZUU
	AEROBIC	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	PILOT	EZZA
	ANAEROBIC	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	EZUU
IMMOBILIZATION	CEMENT SOLIDIFICATION	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	FHMF
	FLYASH SOLIDIFICATION	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	FHMF
	CARBONATE IMMOBILIZATION	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	FHMF
PHYSICAL/-CHEMICAL	REDUCTION/OXIDATION	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	FULL	EWFZ
	DECHLORINATION	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	EUTV
	SOIL WASHING	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	EUQW
	LOW TEMP STRIPPING	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	FULL	EXPE
	LOW TEMP STRIPPING	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/SANDY	PILOT	FCSF
	LOW TEMP STRIPPING	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	EZYQ
THERMAL	INCINERATION	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	BENCH	FDBP
	ROTARY KILN	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	PILOT	EZUY
	ROTARY KILN	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	PILOT	EUZM
	INFRARED	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	PILOT	EWQD
	INFRARED	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/CLAYEY	PILOT	EZZB
	CIRCULATING BED COMBUST	W01	HALOGENATED NON-POLAR AROMATIC COMPOUNDS	SOIL/GENERIC	PILOT	EUXM

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TABLE 3.4. Continued

(W02 Dioxins/Furans/PCBs & Their Precursors)

Treatment Category	Treatment Process	Contaminant Groups/Codes	Media	Scale	Document Number
BIOLOGICAL	AEROBIC	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SLUDGE/-OTHER	PILOT	FCQP
PHYSICAL/-CHEMICAL	DECHLORINATION	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	PILOT	EUZD
	DECHLORINATION	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	BENCH	FBZZ-1
	DECHLORINATION	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	BENCH	FCFR-6
	DECHLORINATION	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SLUDGE/-OTHER	BENCH	FCLC
	SOIL WASHING	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/SANDY	BENCH	EUZU
	SOIL WASHING	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/SANDY	FULL	EVAR
	SOIL WASHING	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/SANDY	BENCH	FRET
	THERMAL DESOP/UV PHOTOLYS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	PILOT	EWGE
THERMAL	INCINERATION	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	BENCH	EZYN
	ROTARY KILN	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/SANDY	FULL	EUZH
	INFRARED	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	PILOT	EUTR
	INFRARED	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	PILOT	EWQD
	INFRARED	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SLUDGE/-OTHER	PILOT	EZZC
	CRITICAL WATER OXIDATION	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/WATERWAY SED	BENCH	FBZZ-2
	PYROLYSIS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/SANDY	PILOT	EXPD
	PYROLYSIS	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	PILOT	FCFR-4
	CIRCULATING BED COMBUST	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	PILOT	EUXM
	CIRCULATING BED COMBUST	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/CLAYEY	PILOT	EWHC
	CIRCULATING BED COMBUST	W02 DIOXINS/FURANS/PCBS & THEIR PRECURSORS	SOIL/GENERIC	PILOT	FCFR-3

TABLE 3.4. Continued

(W03 Halogenated Phenols, Cresols, Ethers, & Thiols)

Treatment Category	Treatment Process	Contaminant Groups/Codes	Media	Scale	Document Number
BIOLOGICAL	BIOLOGICAL	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	SOIL/GENERIC	PILOT	EWGC
IMMOBILIZATION	CEMENT SOLIDIFICATION	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	SOIL/GENERIC	BENCH	FHMF
	FLYASH SOLIDIFICATION	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	SOIL/GENERIC	BENCH	FHMF
	CARBONATE IMMOBILIZATION	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	SOIL/GENERIC	BENCH	FHMF
PHYSICAL/-CHEMICAL	DECHLORINATION	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	SOIL/GENERIC	BENCH	EUTV
	SOIL WASHING	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	SOIL/SANDY	BENCH	EUZU
	SOIL WASHING	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	SOIL/GENERIC	BENCH	EUQW
	LOW TEMP STRIPPING	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	SOIL/GENERIC	BENCH	EZYQ
THERMAL	INCINERATION	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	SOIL/GENERIC	BENCH	FDBP
	ROTARY KILN	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	SOIL/SANDY	FULL	EUZH
	ROTARY KILN	W03 HAL PHENOLS, CRESOLS, ETHERS, & THIOLS	SOIL/GENERIC	PILOT	EUZM

TABLE 3.4. Continued

(W04 Halogenated Aliphatic Compounds)

Treatment Category	Treatment Process	Contaminant Groups/Codes	Media	Scale	Document Number
BIOLOGICAL	AEROBIC	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/GENERIC	PILOT	EZZA
IMMOBILIZATION	CEMENT SOLIDIFICATION	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/GENERIC	BENCH	FHMF
	FLYASH SOLIDIFICATION	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/GENERIC	BENCH	FHMF
	CARBONATE IMMOBILIZATION	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/GENERIC	BENCH	FHMF
PHYSICAL/-CHEMICAL	REDUCTION/OXIDATION	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/GENERIC	FULL	EWFZ
	DECHLORINATION	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/GENERIC	BENCH	EUTV
	SOIL WASHING	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/GENERIC	BENCH	EUQW
	LOW TEMP STRIPPING	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/SILTY	PILOT	EUQS
	LOW TEMP STRIPPING	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/GENERIC	FULL	EXPE
	LOW TEMP STRIPPING	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/GENERIC	BENCH	FCMK
PHYSICAL/-CHEMICAL	LOW TEMP STRIPPING	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/SANDY	PILOT	FCSF
	LOW TEMP STRIPPING	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/GENERIC	BENCH	EZYQ
THERMAL	INCINERATION	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/GENERIC	BENCH	FDBP
	ROTARY KILN	W04 HALOGENATED ALIPHATIC COMPOUNDS	SLUDGE/OILY	PILOT	EXPC
	ROTARY KILN	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/GENERIC	PILOT	EUZM
	INFRARED	W04 HALOGENATED ALIPHATIC COMPOUNDS	SOIL/CLAYEY	PILOT	EZZB

TABLE 3.4. Continued

(W05 Halogenated Cyclic Aliphatics/Ethers/Esters/Ketones)

Treatment Category	Treatment Process	Contaminant Groups/Codes	Media	Scale	Document Number
THERMAL	INCINERATION	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	SOIL/GENERIC	BENCH	EZYN
	INCINERATION	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	SOIL/GENERIC	BENCH	FDBP
	ROTARY KILN	W05 HAL CYC ALIPHATICS/ETHERS/ESTERS/KETONES	SOIL/GENERIC	PILOT	EZUY

TABLE 3.4. Continued

(W06 Nitrated Aromatic & Aliphatic Compounds)

Treatment Category	Treatment Process	Contaminant Groups/Codes	Media	Scale	Document Number
BIOLOGICAL	COMPOSTING	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	SOIL/LAGOON SED	PILOT	EURS
	COMPOSTING	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	SOIL/SANDY	PILOT	EURT
PHYSICAL/-CHEMICAL	CHEMICAL EXTRACTION	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	SOIL/LAGOON SED	BENCH	EURU
THERMAL	INCINERATION	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	SOIL/LAGOON SED	BENCH	EUWW1
	ROTARY KILN	W06 NITRATED AROMATIC & ALIPHATIC COMPOUNDS	SOIL/GENERIC	PILOT	EURP

TABLE 3.4. Continued

(W07 Heterocyclics & Simple Non-Hal Aromatics)

Treatment Category	Treatment Process	Contaminant Groups/Codes		Media	Scale	Document Number
BIOLOGICAL	AEROBIC	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/GENERIC	PILOT	EZZA
IMMOBILIZATION	CEMENT SOLIDIFICATION	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/GENERIC	BENCH	FHMF
	FLYASH SOLIDIFICATION	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/GENERIC	BENCH	FHMF
	CARBONATE IMMOBILIZATION	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/GENERIC	BENCH	FHMF
PHYSICAL/CHEMICAL	REDUCTION/OXIDATION	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/GENERIC	FULL	EWFZ
	DECHLORINATION	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/GENERIC	BENCH	EUTV
	SOIL WASHING	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/ROCKS	FULL	EUTT
	SOIL WASHING	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/GENERIC	BENCH	EUQW
PHYSICAL/CHEMICAL	LOW TEMP STRIPPING	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/SILTY	PILOT	EUQS
	LOW TEMP STRIPPING	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/GENERIC	FULL	EXPE
	LOW TEMP STRIPPING	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/GENERIC	BENCH	FCMK
	LOW TEMP STRIPPING	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/SANDY	PILOT	FCSF
	LOW TEMP STRIPPING	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SLUDGE/OILY	PILOT	FCSP-1
	LOW TEMP STRIPPING	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/GENERIC	BENCH	EZYQ
THERMAL	INCINERATION	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/GENERIC	BENCH	FDBP
THERMAL	ROTARY KILN	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SLUDGE/OILY	PILOT	EXPC
	ROTARY KILN	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/GENERIC	PILOT	EUZM
	INFRARED	W07	HETEROCYCLICS & SIMPLE NON-HAL AROMATICS	SOIL/CLAYEY	PILOT	EZZB

TABLE 3.4. Continued

(W08 Polynuclear Aromatics)

Treatment Category	Treatment Process	Contaminant Groups/Codes	Media	Scale	Document Number
BIOLOGICAL	BIOLOGICAL	W08 POLYNUCLEAR AROMATICS	SOIL/GENERIC	PILOT	EWGC
	AEROBIC	W08 POLYNUCLEAR AROMATICS	SOIL/GENERIC	PILOT	EZZA
	COMPOSTING	W08 POLYNUCLEAR AROMATICS	SOIL/SANDY	BENCH	EUQX
IMMOBILIZATION	CEMENT SOLIDIFICATION	W08 POLYNUCLEAR AROMATICS	SOIL/GENERIC	BENCH	FHMF
	FLYASH SOLIDIFICATION	W08 POLYNUCLEAR AROMATICS	SOIL/GENERIC	BENCH	FHMF
	CARBONATE IMMOBILIZATION	W08 POLYNUCLEAR AROMATICS	SOIL/GENERIC	BENCH	FHMF
PHYSICAL/-CHEMICAL	DECHLORINATION	W08 POLYNUCLEAR AROMATICS	SOIL/GENERIC	BENCH	EUTV
	SOIL WASHING	W08 POLYNUCLEAR AROMATICS	SOIL/SILTY	FULL	EUTT
	SOIL WASHING	W08 POLYNUCLEAR AROMATICS	SOIL/ROCKS	FULL	EUTT
	SOIL WASHING	W08 POLYNUCLEAR AROMATICS	SOIL/SANDY	FULL	EVAR
	SOIL WASHING	W08 POLYNUCLEAR AROMATICS	SOIL/GENERIC	BENCH	EUQW
	LOW TEMP STRIPPING	W08 POLYNUCLEAR AROMATICS	SOIL/GENERIC	FULL	EXPE
	LOW TEMP STRIPPING	W08 POLYNUCLEAR AROMATICS	SLUDGE/OILY	PILOT	FCSP-1
	LOW TEMP STRIPPING	W08 POLYNUCLEAR AROMATICS	SOIL/GENERIC	BENCH	EZYQ
THERMAL	INCINERATION	W08 POLYNUCLEAR AROMATICS	SOIL/GENERIC	BENCH	EZYN
	ROTARY KILN	W08 POLYNUCLEAR AROMATICS	SOIL/GENERIC	PILOT	EUZM
	INFRARED	W08 POLYNUCLEAR AROMATICS	SOIL/CLAYEY	PILOT	EZZB

TABLE 3.4. Continued

(W09 Other Polar Organic Compounds)

Treatment Category	Treatment Process	Contaminant Groups/Codes	Media	Scale	Document Number
BIOLOGICAL	BIOLOGICAL	W09 OTHER POLAR ORGANIC COMPOUNDS	SOIL/GENERIC	PILOT	EURK
	AEROBIC	W09 OTHER POLAR ORGANIC COMPOUNDS	SOIL/GENERIC	PILOT	EZZA
IMMOBILIZATION	CEMENT SOLIDIFICATION	W09 OTHER POLAR ORGANIC COMPOUNDS	SOIL/GENERIC	BENCH	FHMF
	FLYASH SOLIDIFICATION	W09 OTHER POLAR ORGANIC COMPOUNDS	SOIL/GENERIC	BENCH	FHMF
	CARBONATE IMMOBILIZATION	W09 OTHER POLAR ORGANIC COMPOUNDS	SOIL/GENERIC	BENCH	FHMF
PHYSICAL/-CHEMICAL	DECHLORINATION	W09 OTHER POLAR ORGANIC COMPOUNDS	SOIL/GENERIC	BENCH	EUTV
	SOIL WASHING	W09 OTHER POLAR ORGANIC COMPOUNDS	SOIL/SANDY	FULL	EVAR
	SOIL WASHING	W09 OTHER POLAR ORGANIC COMPOUNDS	SOIL/GENERIC	BENCH	EUQW
	LOW TEMP STRIPPING	W09 OTHER POLAR ORGANIC COMPOUNDS	SOIL/GENERIC	FULL	EXPE
	LOW TEMP STRIPPING	W09 OTHER POLAR ORGANIC COMPOUNDS	SLUDGE/OILY	PILOT	FCSP-1
	LOW TEMP STRIPPING	W09 OTHER POLAR ORGANIC COMPOUNDS	SOIL/GENERIC	BENCH	EZYQ
THERMAL	INCINERATION	W09 OTHER POLAR ORGANIC COMPOUNDS	SOIL/GENERIC	BENCH	EZYN
THERMAL	INCINERATION	W09 OTHER POLAR ORGANIC COMPOUNDS	SOIL/GENERIC	BENCH	FDBP
	ROTARY KILN	W09 OTHER POLAR ORGANIC COMPOUNDS	SOIL/GENERIC	PILOT	EUZM
	INFRARED	W09 OTHER POLAR ORGANIC COMPOUNDS	SOIL/CLAYEY	PILOT	EZZB

TABLE 3.4. Continued

(W10 Non-Volatile Metals)

Treatment Category	Treatment Process	Contaminant Groups/Codes	Media	Scale	Document Number
IMMOBILIZATION	STABILIZATION	W10 NON-VOLATILE METALS	SOIL/GENERIC	BENCH	FCAK
	CEMENT SOLIDIFICATION	W10 NON-VOLATILE METALS	SOIL/GENERIC	BENCH	EUXT
	CEMENT SOLIDIFICATION	W10 NON-VOLATILE METALS	SOIL/GENERIC	BENCH	FHMF
	FLYASH SOLIDIFICATION	W10 NON-VOLATILE METALS	SLUDGE/METAL FNSH	PILOT	FAAP
	FLYASH SOLIDIFICATION	W10 NON-VOLATILE METALS	SOIL/GENERIC	BENCH	FHMF
	CARBONATE IMMOBILIZATION	W10 NON-VOLATILE METALS	SOIL/GENERIC	BENCH	FHMF
PHYSICAL/-CHEMICAL	DECHLORINATION	W10 NON-VOLATILE METALS	SOIL/GENERIC	BENCH	EUTV
	SOIL WASHING	W10 NON-VOLATILE METALS	SOIL/GENERIC	BENCH	EUQW
	LOW TEMP STRIPPING	W10 NON-VOLATILE METALS	SOIL/GENERIC	BENCH	EZYQ
THERMAL	INCINERATION	W10 NON-VOLATILE METALS	SOIL/LAGOON SED	BENCH	EUWW1
	INCINERATION	W10 NON-VOLATILE METALS	SOIL/GENERIC	BENCH	EZYN
	ROTARY KILN	W10 NON-VOLATILE METALS	SLUDGE/OILY	PILOT	EXPC
	ROTARY KILN	W10 NON-VOLATILE METALS	SOIL/GENERIC	PILOT	EUZM

TABLE 3.4. Continued

(W11 Volatile Metals)

Treatment Category	Treatment Process	Contaminant Groups/Codes	Media	Scale	Document Number
IMMOBILIZATION	STABILIZATION	W11 VOLATILE METALS	SOIL/CLAYEY	BENCH	EURY
	STABILIZATION	W11 VOLATILE METALS	SOIL/GENERIC	BENCH	FCAK
	CEMENT SOLIDIFICATION	W11 VOLATILE METALS	SOIL/GENERIC	BENCH	EUXT
	CEMENT SOLIDIFICATION	W11 VOLATILE METALS	SOIL/GENERIC	BENCH	FHMF
	FLYASH SOLIDIFICATION	W11 VOLATILE METALS	SOIL/CLAYEY	BENCH	EURY
IMMOBILIZATION	FLYASH SOLIDIFICATION	W11 VOLATILE METALS	SLUDGE/-METAL FNSH	PILOT	FAAP
	FLYASH SOLIDIFICATION	W11 VOLATILE METALS	SOIL/GENERIC	BENCH	FHMF
	CARBONATE IMMOBILIZATION	W11 VOLATILE METALS	SOIL/GENERIC	BENCH	FHMF
PHYSICAL/-CHEMICAL	REDUCTION/-OXIDATION	W11 VOLATILE METALS	SOIL/GENERIC	FULL	EWFZ
	DECHLORINATION	W11 VOLATILE METALS	SOIL/GENERIC	BENCH	EUTV
	SOIL WASHING	W11 VOLATILE METALS	SOIL/SILTY	FULL	EUTT
	SOIL WASHING	W11 VOLATILE METALS	SOIL/GENERIC	BENCH	EUQW
	LOW TEMP STRIPPING	W11 VOLATILE METALS	SOIL/GENERIC	BENCH	EZYQ
THERMAL	INCINERATION	W11 VOLATILE METALS	SOIL/LAGOON SED	BENCH	EUWW1
THERMAL	INCINERATION	W11 VOLATILE METALS	SOIL/GENERIC	BENCH	EZYN
	ROTARY KILN	W11 VOLATILE METALS	SLUDGE/OILY	PILOT	EXPC
	ROTARY KILN	W11 VOLATILE METALS	SOIL/GENERIC	PILOT	EUZM

TABLE 3.4. Continued

(W12 Other Inorganics)

Treatment Category	Treatment Process	Contaminant Groups/Codes	Media	Scale	Document Number
IMMOBILIZATION	FLYASH SOLIDIFICATION	W12 OTHER INORGANICS	SLUDGE/-METAL FNSH	PILOT	FAAP
PHYSICAL/-CHEMICAL	SOIL WASHING	W12 OTHER INORGANICS	SOIL/SILTY	FULL	EUTT
THERMAL	INCINERATION	W12 OTHER INORGANICS	SOIL/LAGOON SED	BENCH	EUWW1

TABLE 3.4. Continued
(W13 Other Organics)

Treatment Category	Treatment Process	Contaminant Groups/Codes	Media	Scale	Document Number
BIOLOGICAL	BIOLOGICAL	W13 OTHER ORGANICS	SOIL/GENERIC	PILOT	EWGC
PHYSICAL/-CHEMICAL	REDUCTION/-OXIDATION	W13 OTHER ORGANICS	SOIL/GENERIC	FULL	EWFZ
	SOIL WASHING	W13 OTHER ORGANICS	SOIL/SILTY	FULL	EUTT
	SOIL WASHING	W13 OTHER ORGANICS	SOIL/ROCKS	FULL	EUTT
	SOIL WASHING	W13 OTHER ORGANICS	SOIL/SANDY	FULL	EVAR
	LOW TEMP STRIPPING	W13 OTHER ORGANICS	SOIL/SILTY	PILOT	EUQS
	LOW TEMP STRIPPING	W13 OTHER ORGANICS	SOIL/GENERIC	FULL	EXPE
	LOW TEMP STRIPPING	W13 OTHER ORGANICS	SOIL/GENERIC	BENCH	FCMK
THERMAL	INCINERATION	W13 OTHER ORGANICS	SOIL/GENERIC	BENCH	FDBP
	ROTARY KILN	W13 OTHER ORGANICS	SLUDGE/OILY	PILOT	EXPC

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Chapter 4

Compilation of Treatability Clearinghouse Abstracts

Abstracts are sorted by Document Number.

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SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Physical/Chemical - Low Temperature Thermal Stripping

Media: Soil/Sandy and Silty

Document Reference: Roy F. Weston, Inc. "Pilot Investigation of Low- Temperature Stripping of Volatile Organic Compounds (VOCs) From Soil: Volume 1 - Technical Report and Volume II - Appendices." Technical report prepared for USATHAMA 123 pp. June 1986.

Document Type: Contractor/Vendor Treatability Study

Contact: Wayne Sisk
U.S. DOD/USATHAMA
Aberdeen Proving Ground, MD 21010-5401
301-571-2054

Site Name: Letterkenny Army Depot, Chambersburg, PA (NPL - Federal facility)

Location of Test: West Chester, PA

BACKGROUND: The U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) is investigating technologies to treat soils contaminated with solvents. A pilot study of low temperature thermal stripping was conducted at Letterkenny Army Depot (LEAD) near Chambersburg, Pennsylvania, from 8/5/85 to 9/16/85.

OPERATIONAL INFORMATION: Soils from two lagoons at LEAD that were used for the disposal of organic liquids were chosen for treatment. The total VOC concentrations in feed soils were approximately 3503 ppm. The soils were sandy and treated at 10 pounds per feed cycle. The unit was designed for processing 385 pounds per hour. Soils were treated in a thermal processor, an indirect heat exchanger which was used to heat and consequently dry the contaminated soil and volatilize the contaminants. Contaminants in the off-gases were thermally destroyed in an afterburner.

The pilot investigation was completed in two phases. Phase I consisted of 18 test runs completed to evaluate the effect on VOC removal efficiency of varying operating conditions (i.e., soil discharge temperature, soil residence time, and air inlet temperature). The 18 test runs were designed in a matrix format to investigate three levels of soil discharge temperature: 50°C, 100°C and 150°C; three levels of soil residence time: 30 minutes, 45 minutes, and 60 minutes; and two levels of air inlet temperature: ambient and 90°C.

Phase II of the Pilot study consisted of 10 "optimization" test runs. There were four primary purposes for the optimization runs: 1) to evaluate the effect on VOC removal efficiency of varying operating conditions beyond the limits set for Phase I of the investigation (i.e., maximum soil discharge temperature and maximum soil residence time); 2) to evaluate the VOC removal rate along the length of the unit; 3) to evaluate the VOC removal efficiency associated with three "duplicate" test runs; and 4) to evaluate the VOC removal efficiency associated with reprocessing soils.

PERFORMANCE: The study concludes that process variables can be manipulated to achieve desired effluent concentrations (i.e., 100 ppm, 10 ppm, 1 ppm, etc.) As conducted, VOCs were removed to concentrations below 100 ppm. The level of removal was a direct and predictable function of VOC feed concentration, residence time, moisture content, heat input, and generating temperature. VOC removal efficiencies associated with an elevated air inlet temperature were generally lower than those associated with ambient air inlet temperature. The appendices provide extensive analytical methods information and other QA/QC information.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W04-Halogenated Aliphatic Solvents	127-18-4	Tetrachloroethene
	156-60-5	Trans-1,2-dichloroethene
	79-01-6	Trichloroethene
W07-Heterocyclics and Simple Aromatics	1330-20-7	Xylenes (Total)
W13-Other Organics	TOT-VOC	Total Volatile Organics

NOTE: **Quality assurance of data may not be appropriate for all uses.**

3/89-1 **Document Number: EUQS**

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SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Physical/Chemical - Soil Washing

Media:	Soil/Generic
Document Reference:	PEI Associates, Inc. "CERCLA BDAT SARM Preparation and Results of Physical Soils Washing Experiments (Final Report)." Prepared for U.S. EPA. Approximately 75 pp. October 1987.
Document Type:	EPA ORD Report Site
Contact:	Richard Traver, Staff Engineer U.S. EPA, ORD Woodbridge Avenue Edison, NJ 08837 201-321-6677
Site Name:	Manufactured Waste (Non-NPL) Site Best Demonstrated Available Technology (BDAT)
Location of Test:	ORD - Edison, NJ

BACKGROUND: This study reports on the results of work preparing 30,000 lbs of SARM or synthetic analytical reference matrix, a surrogate soil containing a wide range of contaminants. It also reports the results of bench scale treatability experiments designed to simulate EPA's mobile soil washing system, where SARM samples were washed to determine the efficiency of using chelating reagent and surfactants to remove contaminants from the SARMs.

OPERATIONAL INFORMATION: SARMs were developed to support testing of various cleanup technologies in support of the Superfund BDAT program. Superfund sites were surveyed to evaluate the type of soils present and the concentrations of contaminant in the soils. The final soil composition selected consists of 30% clay, 25% silt, 20% sand, 20% topsoil and 5% gravel. A prescribed list of chemicals were added to the soils. The contaminants include volatile and semi-volatile organics, chlorinated organic compounds and the metals Pb, Zn, Cd, As, Cu, Cr and Ni. Four different SARM formulations were prepared containing high and low levels of metals and organics. They will be used by the EPA in subsequent treatability studies.

Different solutions containing SARM samples were tested in bench scale shaker tests to determine the ability of a chelant (EDTA), a sufactact (TIDE) and plain water solvent to remove various contaminants from the fine and coarse fractions of soils. The degree of contamination in both the coarse and fine fraction was determined by TCLP tests and total waste analysis (SW-846, 3rd edition). A QA/QC discussion is contained in the report and a complete QA/QC plan is appended.

PERFORMANCE: After samples were treated on the bench scale shaker table the SARM soils were put through a wet sieve to separate fine from coarse materials and the fractions were analyzed using TCLP tests and total analysis. Tap water was as effective in removing the VOC as the other solutions. PH and temperature had very little effect on VOC reduction. The semi-volatile organics were removed slightly better by the 0.5% TIDE than plain tap water. A chelant concentration of 3 moles of EDTA to total metals was most effective in removing metals. Chelant reaction time for removal was 15 to 30 minutes. Arsenic and chromium showed the poorest removal efficiencies while Cd, Zn, Cu and Ni were easily chelated by EDTA. The soil is divided into three particle size classes > 2 mm, 2 mm to 250 µm and < 250 µm. The washes removed contaminants from the 2 larger classes of soils to levels below the proposed TCLP limits. These soil classes comprise 42% by weight of the SARM and could potentially be classified as non-hazardous and be returned to the site. The contaminated fines could be stabilized and treated further. This study revealed the SARM could be cleaned by soils washing and the contaminated soil volume could be reduced..

CONTAMINANTS:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Nonpolar Aromatic Compounds	108-90-7	Chlorobenzene
W03-Halogenated Phenols, Cresols, Ethers, and Thiols	87-86-5	Pentachlorophenol
W04-Halogenated Aliphatic Compounds	107-06-2	1,2-Dichloroethane
	127-18-4	Tetrachloroethene
W07-Simple Nonpolar Aromatics and Heterocyclics	100-42-5	Styrene
	1330-20-7	Xylenes
	100-41-4	Ethylbenzene
W08-Polynuclear Aromatics	120-12-7	Anthracene
W09-Other Polar Organic Compounds	117-81-7	Bis(2-ethylhexyl)phthalate
	67-64-1	Acetone
W10-Non-Volatile Metals	7440-50-8	Copper
	7440-02-0	Nickel
	7440-47-3	Chromium
W11-Volatile Metals	7439-92-1	Lead
	7440-66-6	Zinc
	7440-43-9	Cadmium
	7440-38-2	Arsenic

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-42 **Document Number: EUQW**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: **Biological - Composting/Biodegradation**

Media: Soil/Sandy

Document Reference: Portier R., et al. "Field Plot Test Report, Phase III Engineering Design, Old Inger Superfund Site, Darrow, Louisiana." Approximately 250 pp. November 1986.

Document Type: Contractor/Vendor Treatability Study

Contact:
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Dallas, TX 75202
214-655-6444

Site Name: Old Inger Site, LA (NPL)

Location of Test: Ascension Parish, LA

BACKGROUND: This project report describes the results of biodegradation with indigenous microorganisms on soils at an oil reclamation plant. The site occupied about 16 acres including a 7.5 acre swamp. The wastes were oily sludges found in lagoons, diked tank containment areas, buried waste areas and in the swamp. Wastes identified at the site were consistent with hazardous materials used at an oil reclamation plant. Benzene, toluene and PAHs were present; no PCBs were found and very low levels of chlorinated hydrocarbons and heavy metals were detected. Numerous PAHs such as naphthalene, methyl naphthalene, anthracene and fluorene were detected in lagoon soils and buried waste soils. The concentrations of PAH compounds ranged from less than 100 ppm to approximately 5700 ppm for phenanthrene.

OPERATIONAL INFORMATION: The purpose of the study was to determine microorganism loading rate on the silt and sandy clay soils. Task I was a screening test to determine the maximum toxicant loading rates. After selection of the loading rate, Task II was mesocosm tests in the laboratory where loading, nutrients and other parameters could be controlled. This included evaluation of commercially available bacterial cultures. Field verification studies (Task III) were conducted on special plots set off at the site and the plots were loaded sequentially with different waste types. The volume of soil which was treated was not reported. The duration of the treatment was 35 days. The report contains a discussion of the mechanism of biodegradation and an appendix showing the actual chemical reaction pathways associated with the biodegradation of various PAH compounds.

PERFORMANCE: Optimal loading rates of the various contaminants were shown to induce microbial biotransformations. All of the compounds studied decreased in concentration over time, but no specific correlations were presented or discussed by the authors. Data that was generated only indicated gross trends and no contaminant destruction efficiencies were reported. Also there was no analysis for toxic intermediates in this study and the authors suggested that toxic intermediate production needed to be evaluated further. No specific QA/QC procedures were reported. The authors state that microbial degradation and detoxification of the site is scientifically verifiable and economically feasible although no discussion of the economics was contained in the study. Post closure monitoring of soils and leachate from the site was recommended for 30 years.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W08-Polynuclear Aromatic	120-12-7	Anthracene
	91-20-3	Naphthalene
	85-01-8	Phenanthrene
	208-96-8	Acenaphthylene
	86-73-7	Fluorene
	206-44-0	Fluoranthene

NOTE: **Quality assurance of data may not be appropriate for all uses.**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: **Biological - Combined Biological**

Media: Soil/generic

Document Reference: GCA Corp. "Endangerment Assessment and Feasibility Study, Picillo Site, Coventry, Rhode Island." Vol. I, III. Prepared for U.S. EPA, Office of Waste Programs Enforcement. 15 pp. March 1985.

Document Type: Contractor/Vendor Treatability Study

Contact:

Kenneth Wrenger
Enforcement Project Manager
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Room 2003
Boston, MA 02203
617-565-3637

Site Name: Picillo Site, RI (NPL)

Location of Test: Coventry, RI

BACKGROUND: This treatability study report consists of limited pages from a study by GCA Corp. Endangerment Assessment and Feasibility Study on the Picillo Site, Coventry, R.I. which reported on the change in contaminant concentrations in several stockpiles of soils. One stockpile containing phenol concentrations up to 870 ppm was landfarmed by spreading and irrigating the waste with microorganisms. Other stockpiles are mentioned but insufficient details are provided to determine treatment methods or results.

OPERATIONAL INFORMATION: Excavated soils were stockpiled in three impoundments. The soils in the area are mainly sand and gravel till. The largest pile (3500 cubic yards) has PCB contamination. A second stockpile (2000 cubic yards) which was contaminated with phenols was landfarmed by spreading the soil on an underdrain and liner system, and irrigating the soil. No details are provided on the microorganisms or other facts related to this irrigation.

PERFORMANCE: Concentrations of PCBs, phenols, and volatile organics were reduced by the treatment. In the large impoundment, concentrations of PCBs were decreased from approximately 700 ppm to an average of 37 ppm after 3 1/2 years by the use of landfarming. Several volatile organics were also present in this stockpile, although the concentrations were not discussed. Landfarming in the second impoundment reduced phenol concentrations from approximately 900 ppm to 70 ppm.

The limited data available does not allow the treatment performance to be accurately assessed. There is no one-to-one correspondence in the analysis of the influent and effluent concentrations. Some contaminants reported effluent concentrations greater than the influent concentrations.

There is no QA/QC information, however, a laboratory working for the state provided the analytical services.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W09-Other Polar Organic Compounds	108-95-2	Phenol

NOTE: **Quality assurance of data may not be appropriate for all uses.**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Thermal Treatment - Rotary Kiln

Media: Soil/generic

Document Reference: Roy F. Weston, Inc. "Incineration Test of Explosives Contaminated Soils at Savanna Army Depot Activity, Savanna, Illinois." Prepared for USATHAMA. Approximately 200 pp. April 1984.

Document Type: Contractor/Vendor Treatability Study

Contact: Wayne Sisk
U.S. DOD/USATHAMA
Aberdeen Proving Ground, MD 21010-5401
301-671-2054

Site Name: Savanna Army Depot (NPL - Federal facility)

Location of Test: Savanna, IL

BACKGROUND: The primary objective of these tests was to demonstrate the effectiveness of incineration as a decontamination method for explosives contaminated soils. A pilot-scale rotary kiln incinerator, manufactured by ThermAll, Inc., was used to treat both sandy and clayey soils which had been contaminated by wastewater from explosives production and demilitarization. The test was performed at Savanna Army Depot Activity (SADA), Illinois, the sandy soils came from SADA and the clayey soils were shipped in from the Louisiana Army Ammunition Plant (LAAP), Louisiana.

OPERATIONAL INFORMATION: The feed soil TNT concentrations ranged from 88,100 ppm to 406,000 ppm. The SADA soil was purposely excavated from more concentrated regions of the lagoon so that a higher destruction removal efficiency (DRE) could be achieved. There were 19 daily tests completed in 20 consecutive days. After the initial run at 500 lb/hr. and 800°F, elevated levels of explosives were detected in the ash, fabric filter ash, and flue gas. Therefore, subsequent runs were conducted on feed rates no higher than 400 lb/hr. and afterburner temperatures no lower than 1200°F. Each run was with approximately 1000 pounds of soil. Primary chamber temperatures of greater than 1400°F were not required.

In addition to these trial burns 25,000 pounds of soil were treated in a six day steady-state production run. This run was at 400 lb/hr, a primary chamber temperature of 1400°F and secondary chamber temperature of 1800°F. These conditions had consistently demonstrated complete destruction of explosives in the stack gas and kiln ash and successfully disposed of all excavated test materials.

PERFORMANCE: The soil residence times could not be measured in the field, so they were estimated from the ash production rate. The residence time averaged 83 minutes for the SADA runs and 72 minutes for the LAAP runs.

TNT concentrations in the soil ash ranged from 2.55 to 26.9 ppm. Only RDX and TNB were detected on one occasion, each as a residual explosive or a combustion by-product in the ash. Ash residues were not hazardous due to the characteristics of EP Toxicity or reactivity.

The document concludes that this incineration system is transportable and can operate under a wide range of conditions. It also demonstrated that ash residues are non-hazardous and stack emissions measured were in compliance with all Federal and state regulations.

QA/QC procedures are included in the report and detailed in an appendix.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group was:

Treatability Group	CAS Number	Contaminants
W06-Nitrated Aromatics & Aliphatics	135-HMX	1,3,5,7-Tetranitro-octahydro-1,3,5,7-tetracyclo-octane (HMX)
	121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
	99-35-4	Trinitrobenzene
	118-96-7	Trinitrotoluene (TNT)
	25154-54-5	Dinitrobenzene
	T99-55-8	2-Amino-4,6-dinitrotoluene

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-3 **Document Number: EURP**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: **Biological - Composting**

Media: Soil/Lagoon Sediment

Document Reference: Atlantic Research Corp. "Composting Explosives/ Organics Contaminated Soils." Technical report prepared for USATHAMA. 198 pp. May 1986.

Document Type: Contractor/Vendor Treatability Study

Contact:
Wayne Sisk
U.S. DOD/USATHAMA
Aberdeen Proving Ground, MD 21010-5401
301-671-2054

Site Name: Badger Army Ammunition Plant (Non-NPL - Federal facility) and Louisiana AAP (NPL - Federal facility)

Location of Test: Baraboo, WI and Shreveport, LA

BACKGROUND: Laboratory scale and pilot scale studies were conducted to evaluate composting to treat sediments and soils containing explosive and organic compounds. Sediment and soil from lagoons at Army ammunition plants, located in Louisiana, Wisconsin and Pennsylvania contained high concentrations of TNT, nitrocellulose, and RDX, and moderate levels of HMX and tetryl. Laboratory experiments using ^{14}C-labeled tracers were used to follow the fate of each explosive. Two types of composts (hay-horse feed and sewage sludge-wood shavings) and three rates of sediment/soil addition to the compost were utilized in these studies.

OPERATIONAL INFORMATION: Six 488 gallon tanks 5 feet in diameter and 4 feet in height were used as composters. These were placed in greenhouses. Two drums of contaminated sediment from a dredging mound were used. The composts were incubated at 60°C with continuous aeration for 6-10 weeks. Offgasses from the composts were monitored for ^{14}C and at the completion of the incubation, composts were analyzed for the explosives, extractable ^{14}C-labeled degradates and unextracted residual ^{14}C.

PERFORMANCE: TNT degraded rapidly in all the sewage sludge composts but breakdown in a hay-horse feed compost was adversely affected by the higher rates of sediment addition. Cleavage of the benzene ring during TNT breakdown did not appear to be significant.

RDX was almost completely degraded in composts amended with sediment during 10 weeks of incubation. Increased rates of sediment addition significantly decreased the rate of RDX breakdown in both hay-horse feed and to a lesser extent in sewage sludge composts. Substantial losses of ^{14}C from the composts as $^{14}CO_2$ demonstrated that RDX is completely metabolized to natural products.

HMX did not degrade in the hay-horse feed composts, but levels were reduced by 30-50% during 10 weeks of incubation in the sewage sludge composts. HMX losses were lowest in the composts with the higher rates of sediment addition.

Tetryl was highly susceptible to degradation by composting. 90-100% tetryl was lost after composting for 44 days. Apparent rates of tetryl breakdown were not strongly influenced by the sediment loading rates.

The half-lives for TNT, RDX, and HMX using the hay-horse feed compost were 1.6, 3.0, and 4.7 weeks, respectively. No loss of explosives in the sewage sludge compost was observed during 7 weeks of composting. Half-lives of TNT, RDX, HMX, and tetryl in the compost of manure mixed with hay and saw dust were 1.0, 2.5, 3.3, and 1.2 weeks, respectively. In the sewage sludge composts 92-97% degradation of cellulose occurred within 4 weeks. Leaching of explosives and heavy metals from the composts was minimal. The economics of full scale composting are presented.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W06-Nitrated Aromatics & Aliphatics	118-96-7	Trinitrotoluene (TNT)
	121-82-4	Hexahydro-1,3,5-Trinitro-1,3,5-triazine (RDX)
	135-HMX	1,3,5,7-Tetranitro-octahydro-1,3,5,7-tetracyclooctane (HMX)
	479-45-8	Tetryl
	9004-70-0	Nitrocellulose

NOTE: **Quality assurance of data may not be appropriate for all uses.**

3/89-4 **Document Number: EURS**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process:	**Biological - Composting**
Media:	Soil/Sandy
Document Reference:	Atlantic Research Corp. "Composting of Explosives." Prepared for USATHAMA. 107 pp. September 1982.
Document Type:	Contractor/Vendor Treatability Study
Contact:	Wayne Sisk U.S. DOD/USATHAMA Aberdeen Proving Ground, MD 21010-5401 301-571-2054
Site Name:	Manufactured Waste (NPL - Federal facility)
Location of Test:	Aberdeen, MD (USATHAMA)

BACKGROUND: This treatability study was conducted by Atlantic Research Corporation for the U.S. Army Toxic and Hazardous Material Agency. The objective of this bench-scale study was to determine the extent to which TNT and RDX concentrations were reduced by composting for a six week period. A second objective was to determine if bench-scale composting studies accurately simulate the activity of larger composts by comparison of parallel studies monitoring TNT and RDX reductions in laboratory studies (50g dry weight) and pilot-scale greenhouse composts (10kg dry weight). A final objective of the study was to determine the leachability of TNT and RDX from the compost.

OPERATIONAL INFORMATION: Labeled ^{14}C-TNT or ^{14}C-RDX were used in the laboratory studies. Radio tracer compounds were utilized to determine the amount of explosives degraded and the mechanism of degradation by composting. Sandy soils were spiked with production grade explosives and a compost consisting of hay and horse feed. This mixture was incubated at approximately 55°C under aerobic conditions.

In the greenhouse studies, pilot-scale composts of approximately 10,000 g of sandy soil containing production grade TNT (2% by weight) RDX (1% by weight) were composted for four to six weeks. Aerobic conditions were maintained in these composts by a forced aeration system and frequent mixing. No external heat source was utilized.

PERFORMANCE: In the laboratory, TNT concentrations were reduced by 82.6% at the end of six weeks of composting. No significant quantities of $^{14}CO_2$ were evolved, indicating that composting did not result in cleavage of the ring structure of the TNT molecule. Trace quantities of reduction products (4-amino-2, 6-dinitrotoluene and 2-amino-4, 6-dinitrotoluene) were found in one of three replicate composts after six weeks of composting. The RDX laboratory composts showed a reduction in the RDX concentration of 78.3% after six weeks of composting. Significant amounts of $^{14}CO_2$ were produced by the RDX compost, indicating that cleavage of the RDX molecule occurred.

The greenhouse compost studies demonstrated a very rapid decrease in the TNT concentration. At the three week sampling time, the initial TNT concentration of 2% had been reduced by 99.9%. Analysis of the four week TNT compost extract confirmed that the TNT concentration in the composed material was below the detection limit of 16.9 ppm. Greenhouse composting of RDX resulted in a 61% reduction in the RDX concentration after three weeks from an initial concentration of 1%, with total reduction of 82% following six weeks of composting. Reduction of RDX and TNT in the leachate to 13 ppm and1.4 ppm respectively paralleled the above results.

QA/QC procedures for the study are not stated; however, the document does report several standard operational procedures for the laboratory analysis.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W06-Nitrated Aromatic and Aliphatics	118-96-7	Trinitrotoluene (TNT)
	121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-5 **Document Number: EURT**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Physical/Chemical - Chemical Extraction

Media:	Soil/Lagoon Sediment
Document Reference:	Environmental Science and Engineering, Inc. "Final Report: Development of Optimum Treatment System for Wastewater Lagoons Phase II - Solvent Extraction Laboratory Testing." Prepared for USATHAMA, 85 pp. October 1984.
Document Type:	Contractor/Vendor Treatability Study
Contact:	Wayne Sisk U.S. DOD/USATHAMA Aberdeen Proving Ground, MD 21010-5401 301-571-2054
Site Name:	Ft. Wingate, NM; Navajo, AZ; and Shreveport, LA (NPL - Federal facility)
Location of Test:	Gainsville, FL

BACKGROUND: The U.S. Army surveyed innovative treatment techniques for restoration of hazardous waste lagoons and selected solvent extraction as cost-effective restoration for further study. This treatability study focuses on treatment of organic (explosive) contaminated lagoon sediments which are the result of munitions production operations. Primary contaminants of concern included the following explosives: TNT, DNT, RDX and Tetryl. This was a laboratory study of solid extraction where the solvent is used in excess and the effectiveness of a single contact is limited by the ability to physically separate the liquid and soil fractions. The treatability goal is to reduce explosive contaminant level to 10 mg/kg.

OPERATIONAL INFORMATION: Sediments tested were obtained from Navajo Army Depot (AD), AZ (predominantly volcanic cinders); Ft. Wingate AD, NM (mostly clay); and Louisiana Army Ammunition Plant. Explosive content of sediments ranged from 0.1-99% and moisture content ranged from 23.8-42.8%. (Report provides characteristics information on sediments.) Acetone was selected as the leaching agent based on the solubility of contaminants, cost, and availability. Laboratory tests included: solubility, leaching efficiencies, and settling tests. Solubility tests evaluated water/acetone ratios to determine optimum operational range for individual contaminants and mixtures. Leaching tests evaluated effectiveness of countercurrent extraction to determine contact time required for equilibrium of explosives between leachate and the sediments. Multiple leaching tests were performed by shaking sediment with acetone/water mixture in 1-liter graduated cylinders for 30 minutes followed by solid-liquid separation. Settling tests were performed on two soils with significant solid content to determine settling rate to aid in design of waste water treatment unit.

Report provides a discussion of sampling and analysis methods and provides limited QA/QC information.

PERFORMANCE: Laboratory leachability studies indicated that wet, explosive-ladened sediments can be effectively decontaminated by leaching with an acetone/water mixture. In general, three to four contact stages of 30 minutes each were required to reduce the explosives level to less than 10 mg/kg. A fifth contact stage with a 50% efficiency would have been required to achieve the goal for the Louisiana sediment. Solubility tests demonstrated a non-linear solubility of explosives with acetone/water. Saturated solutions between 50 and 90% acetone form a two-phase liquid solution which should be avoided since this could hinder penetration of solvent through sediment. A conceptual treatment system design is provided based on results of tests. Calculated 4 stage removal efficiencies are shown in the bottom table.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W06-Nitrated Aromatic Compounds	118-96-7	Trinitrotoluene (TNT)
	99-35-4	Trinitrobenzene (TNB)
	121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)

Initial Sediment Explosives Concentration, Final Sediment Explosives Concentration, and Calculated 4-Stage Removal Efficiencies

Sediment	Initial Explosives Concentrations (mg/Kg)	Final Explosives Concentrations (mg/kg)	4-Stage Removal Efficiency %
Ft. Wingate AD	1,200	6.0	99.5
Navajo AD	19,000	7.0	99.96
Louisiana	420,000	17.0	99.996

NOTE: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-45 Document Number: EURU

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: **Immobilization - Cement and Fly Ash Solidification**

Media: Soil/Clayey

Document Reference: Ecology and Environment, Inc. "Summary Report on the Field Investigation of the Sapp Battery Site. Jackson County, Florida." Approximately 170 pp. in two volumes. Technical report prepared for Florida Department of Environmental Regulation (FDER). November 1986.

Document Type: Contractor/Vendor Treatability Study

Contact:
Kristen Toepen
U.S. EPA - Region IV
345 Courtland Street, N.E.
Atlanta, GA 30365
404-347-4727

Site Name: Sapp Battery Site, Jackson County, FL (NPL)

Location of Test: Jackson County, FL

BACKGROUND: This treatability study presents the results of field investigations at the Sapp Battery site in Florida, an abandoned battery recycling operation. The site is estimated to contain 14,300 cubic yards of soils with lead levels in excess of 1,000 ppm. The soils in the immediate vicinity of the site are a mixture of brown sand and yellow-brown sandy loam to a depth of five feet. A detailed QA/QC plan and analytical protocols is described in the second volume to the study. A sampling program and fixation study was conducted to evaluate cementitious and pozzolanic cementation technologies for leachate minimization potential. This abstract will focus on the fixation study and the ability of the processes evaluated to immobilize heavy metals.

OPERATIONAL INFORMATION:The cement base solidification process involves sealing the contaminated soil in a portland cement matrix. The pozzolanic process involves sealing the contaminated soil in a matrix of lime and fly ash. Soil samples from 0 to 5 and 5 to 10 foot depth intervals were composited and used. Analysis of the composite sample showed 7100 mg/kg of lead. Soil samples were mixed with varying percentages of solidification agent and water and allowed to set.

PERFORMANCE: Three pozzolanic, three cementitious solidification mixes and one control were prepared for the EP Toxicity leaching test. The results of the chemical fixation analysis are shown in the table on the next page. The results indicate that the cementitious mixture was much more effective in binding lead than the pozzolanic cement mixture (fly ash and lime). The portland cement mixture exhibited excellent binding capacity for all samples (1126A through C). Compared to the maximum allowable concentration of 5 mg/liter (EP Toxicity), the analysis of the fixed samples were at or near the lead detection limit. Lead concentrations in the leachate from the pozzolanic mixture were much higher than in the portland cement mixture. The authors offer no explanation for the difference but did indicate that the soils can be solidified to reduce lead concentrations in the leachate to acceptable levels. It is anticipated that cement requirements could be reduced and heavy metal control increased through process optimization.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W11-Volatile Metals	439-92-1	Lead

NOTE: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-29 **Document Number: EURY**

Results of Chemical Analysis of Extracts From EP Toxicity Tests

	Samples				Maximum Allowable EP Toxicity Concentrations (mg/l)
Pozzolanic					
E & E Lab Number 86- *	1126D	1126E	1126F		
Sample Identity	Ash: Lime: Soil: 0.25: 0.25: 1	Ash: Lime: Soil: 0.5: 0.5: 1	Ash: Lime: Soil: 0.75: 0.75: 1	Blank	
Lead (mg/l)	76.4	< 0.06	7.17	< 0.06	5.0
Cementitious					
E & E Lab Number 86-*	1126A	1126B	1126C		
Sample Identity	Concrete: Soil 0.5:1	Concrete: Soil 1:1	Concrete: Soil 1.5:1		
Lead (mg/l)	0.085	< 0.06	< 0.06		5.0

* 86-1126 is a composite of 9 samples. The untreated composite sample has a lead concentration of 71,000 mg/kg. The EP Toxicity Test on the control sample (untreated composite soil material) yielded 59.4 mg/l.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Thermal Treatment - Infrared Incineration

Media: Soil/generic

Document Reference: Shirco Infrared Systems. "Final Report: On-Site Incineration of Shirco Infrared Systems Portable Pilot Test Unit, Times Beach Dioxin Research Facility, Times Beach, Missouri." Technical report prepared for U.S. EPA. approx. 200 pp. November 1985.

Document Type: Contractor/Vendor Treatability Study

Contact:
U.S. EPA - Region VII
726 Minnesota Avenue
Kansas City, KS 66101
913-236-2800

Site Name: Times Beach Dioxin Research Facility, MO (NPL)

Location of Test: Times Beach, MO

BACKGROUND: During the period of July 8 - July 12, 1985, the Shirco Infrared Systems Portable Pilot Test Unit was in operation at the Times Beach Dioxin Research Facility to demonstrate the capability of Shirco's infrared technology to decontaminate silty soil laden with 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) at a concentration range of 156 to 306 ppb. Emissions sampling and final analysis was performed by Environmental Research & Technology, Inc. (ERT), while laboratory analysis of the emissions and soil samples was performed by Roy F. Weston Inc. Shirco Infrared Systems prepared the testing procedure protocol and operated the furnace system.

OPERATIONAL INFORMATION: A single 55 gallon drum of contaminated road bed soil which had been screened through 1/2 inch mesh and homogenized in a mixer was used. Two primary furnace solid phase residence times were evaluated: 30 minutes and 15 minutes. Emissions and soil sample testing accompanied both of these tests. A consistent furnace feed rate averaging 47.7 lb/hr at a 1 inch bed depth was maintained during the 30 minute residence time test. The feed rate during the 15 minute residence time test averaged 48.1 lb/hr with a 0.75 inch bed depth.

An important process parameter during testing was chamber temperature, in both the primary and secondary chambers. Over the effective process length of the primary chamber, temperature was controlled in two equal length zones. During the 30 minute residence time test, the feed end zone maintained a nominal temperature of 1560°F and the discharge end zone maintained a nominal 1550°F. For the 15 minute residence time test, the respective temperatures were both 1490°F. The secondary combustion chamber was heated by a propane burner and its temperature was maintained above 2200°F during both tests. The nominal secondary chamber temperatures were 2250°F and 2235°F, respectively, for the 30 and 15 minute primary chamber residence time tests.

PERFORMANCE: For both tests, the soil discharge concentration of 2,3,7,8-TCDD was less than 38 parts per trillion. Based upon the expected detection limit of 50 picograms of 2,3,7,8-TCDD as measured by the Weston GC/MS system and the sampling volume capability of the ERT emissions test equipment, the feed rates were more than adequate to confirm the required 99.9999% Destruction Removal Efficiency (DRE). Particulate emissions were well below the standard of .08 gi/SCF @ 7% 0_2. Laboratory QA/QC procedures are discussed in the report.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02-Dioxins/Furans/PCBs	1746-01-6	Tetrachlorodibenzo-p-dioxin (TCDD)

NOTE: Quality assurance of data may not be appropriate for all uses.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Physical/Chemical - Soil Washing/Chemical Extraction

Media: Soil/Silty

Document Reference: Assink, J.W. "Extractive Methods for Soil Decontamination, A General Survey and Review of Operational Treatment Installations." Apeldoorn, Netherlands. Technical Report. 13 pp. November 1985.

Document Type: Contractor/Vendor Treatability Study

Contact:
U.S. EPA, ORD
HWERL
Woodbridge Avenue
Edison, NJ 08837-3579
212-264-2525

Site Name: Ecotechniek BV (Non-NPL)

Location of Test: Netherlands

BACKGROUND: The treatability study report provides a general overview of soil decontamination by extraction and reports on the field application of three specific different soil washing/solvent extraction systems. Each system is similar in design and removed contaminants from soil including crude oil and metals.

OPERATIONAL INFORMATION: The soil to be cleaned is mechanically pretreated to remove large objects such as pieces of wood, vegetation remains, concrete, stones, and drums, while hard clods of soil are reduced in size. The sieve residue may be cleaned separately. The pretreated soil is then mixed with an extracting agent such as acids, bases, surface active agents, etc. The primary purpose of this step is to transfer the contaminants to the extraction fluid, either as particles or as a solute.

The soil and the extracting agent are separated. The contaminants, the smaller soil particles (clay and silt particles) and the soluble components in the soil are generally carried off with the extraction agent. The soil undergoes subsequent washing with clean extracting agents and/or water to remove as much of the remaining extraction fluid as possible. The larger particles carried off with the extraction phase are separated as best as possible and, if required, undergo a subsequent washing with clean extracting agent. The contaminated extraction fluid is cleaned and can be re-used after the addition of chemicals.

PERFORMANCE: All types of contaminants may be removed from the soil by extraction if they can be dissolved in the extracting agent or dispersed in the extraction phase. Extraction is especially suitable for sandy soil, low in humus and clay content, because of the sand particles' (50-80 µm) relatively high settling velocity. Sludge residue from this process generally has to be disposed of. Currently, four installations for extractive cleaning of excavated soil are operational in the Netherlands. The operational soil washing installations have proven successful for removing cyanides; PNAs (polynuclear aromatics) and mineral oil; heavy metals; halogenated hydrocarbons and other contaminants with efficiencies exceeding 80% (see bottom table).

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W07-Heterocyclics & Simple Aromatics	TOT-AR	Aromatic Hydrocarbons
W08-Polynuclear Aromatics	TOT-PAH	Total Polycyclic Aromatic Hydrocarbons
W11-Volatile Metals	7439-92-1	Lead
W12-Other Inorganics	7440-66-6	Zinc
W13-Other Organics	57-12-5	Cyanide
	TOX	Total organic halogens
	CRUDE	Crude Oil

Contaminant Removal Efficiency

Contaminant	Initial Concentration ppm	Final Concentration After Treatment	Removal Efficiency % (approximate)
CN (galvanic)	450	15	94
Zn	1600-3000	300-500	83
Cd	66-125	5-10	92
Ni	250-890	85-95	66-89
Pb	100	25	75
Aromatics	240	41	81
PNAs	295	15	95
Crude Oil	79	2.3	97

NOTE: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-10 Document Number: EUTT

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Physical/Chemical - Dechlorination

Media: Soil/Generic

Document Reference: Tierman, T.O., Ph.D., "Development of Treatment Data on the KPEG Process for CERCLA/BDAT Standards." Approximately 60 pp. Prepared for U.S. EPA, HWERL. January 1988.

Document Type: Contractor/Vendor Treatability Study

Contact:
C. Rogers
U.S. EPA, HWERL
Cincinnati, OH 45268
513-569-7757

Site Name: BDAT SARM - Manufactured Waste (Non-NPL)

Location of Test: Wright State University, Dayton, Ohio

BACKGROUND: This report describes the results of laboratory studies on KPEG treatment of synthetic soils contaminated with a variety of compounds, both organic and inorganic. The U.S. EPA provided soils to Wright State University to conduct the KPEG study. Problems were encountered in obtaining homogeneous soil samples and in the analysis of contaminants in the soils and in the analysis for VOCs in the reaction products of the KPEG treatment tests.

OPERATIONAL INFORMATION: EPA provided 50 pounds each of four different standard analytical reference matrix (SARM) samples which were prepared under a separate work assignment. Each of the soil samples were spiked with different concentrations of known volatile organic compounds (ethylbenzene, xylene, tetrachloroethylene, chlorobenzene, styrene, 1,2-dichloroethane and acetone), three semi-volatiles (anthracene, bis (2-ethylphenyl) phthalte and pentachlorophenol) and seven metals (Cd, Ca, Cr, Pb, As, Ni and Zn). The authors found the SARM soil samples to be non-homogenous with condensation and pooling of the liquid contaminants occurring in the soil samples. Samples could not be homogenized due to the high moisture content of the sample. 500 gram aliquots of the SARM soils were removed, placed in a two liter reaction vessel and reacted with KPEG for 1 hour at 100°C to observe if the KPEG process effectively removed certain contaminants. The KPEG reagent was provided by the U.S. EPA. Samples before and after treatment were measured by purge/trap GC/MS. The analytical procedures had to be extensively modified due to the high levels of contaminants present in the reaction products. The author attributed the substantial scatter in the results to the problem of the nonhomogenous SARM that were used. Heavy metal analyses were performed by an EPA CLP Laboratory.

PERFORMANCE: The metal analysis in treated and untreated samples revealed that KPEG treatment and subsequent water washing did not reduce the metal concentrations. Overall metal materials balance was poor. The volatile and semi-volatile organic data also exhibited very poor mass balance and a large scatter in results. However, the KPEG appears to have reacted with and essentially completely destroyed dichloroethane and tetrachloro-ethylene. The other two chlorinated organics were not destroyed since temperatures higher than 100°C are required to dechlorinate these compounds. The other organic compounds, xylene, ethylbenzene and styrene do not appear to be destroyed by this treatment. The acetone data is suspect due to volatility problems, instrument saturation, etc. A QA review could not be conducted due to the enormous concentrations of the analyte present in the various samples and the inapplicability of EPA analytical methods. The analytical data obtained are believed to be, at best, semi-quantitative indicators of the KPEG processes ability to treat contaminated soils.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminates by treatability group is:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Aromatic Compounds	108-90-7	Chlorobenzene
W03-Halogenated Phenols, Cresols and Thiols	87-86-5	Pentachlorophenol
W04-Halogenated Aliphatic Solvents	107-06-2	1,2-dichloroethane
	127-18-4	Tetrachloroethene
W07-Heterocyclics and Simple Aromatics	100-41-4	Ethylbenzene
	100-42-5	Styrene
	1330-20-7	Xylene (total)
W08-Polynuclear Aromatics	120-12-7	Anthracene
W09-Other Polar Organic Compounds	67-64-1	Acetone
	117-81-7	bis (2-ethyl hexyl) phthalate
W10-Non-Volatile Metals	7440-47-3	Chromium
	7440-50-8	Copper
	7440-02-0	Nickel
W11-Volatile Metals	7440-38-2	Arsenic
	7440-43-9	Cadmium
	7439-92-1	Lead
	7440-66-6	Zinc

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-37 **Document Number: EUTV**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process:	**Thermal Treatment - Incineration**
Media:	Soil/Lagoon Sediment
Document Reference:	Atlantic Research Corp. "Engineering and Development Support of General Decon Technology for the U.S. Army's Installation/Restoration Program." Prepared for USATHAMA under contract DAAK11-80-C0027. Four volumes with a total of approximately 500 pp. April-June 1982.
Document Type:	Contractor/Vendor Treatability Study
Contact:	Wayne Sisk U.S. DOD/USATHAMA Aberdeen Proving Ground, MD 21010-5401 301-671-2054
Site Name:	Louisiana Army Ammunition Plant (NPL - Federal facility)
Location of Test:	Atlantic Research Corp., Alexandria, VA

BACKGROUND: This document reports on the results of bench-scale tests of treatment technologies for explosive-containing sediment located in lagoons at Army ammunition plants. A companion literature search identified the appropriate explosives remediation technologies to be evaluated. Cost estimates for various treatment technologies were made based on the laboratory data.

OPERATIONAL INFORMATION: Sediment samples contaminated with the explosives TNT, RDX, tetryl and nitro cellulose from the Louisiana Army Ammunition Plant were used in the laboratory tests. Explosive levels in lagoon #4 sediments were at or below 1000 µg/g. Samples from lagoons 9 and 11 had much higher RDX and TNT levels (1000 to 109,000 µg/gm of soil). The report contains a detailed QA/QC plan and analytical protocol.

PERFORMANCE: Incineration tests were conducted by placing approximately 4g of sediment in a crucible and placing the crucibles in a muffle furnace for varying amounts of time. Residues were analyzed for contaminants of interest. Table I shows the results of the incineration tests. Incineration at temperatures as low as 300-500°C for 30 minutes time can remove all the contaminants from the sediments. While all of the explosives can be reduced to their detection limits at the lower temperatures, it is possible that some toxic decomposition products may remain. It is, therefore, important to use temperatures which reduce the total organic contents as measured by chemical oxygen demand (COD) to acceptable levels. This can be accomplished at temperatures of 500°-700°C and reaction times of 30 minutes. Since explosive volatilization may occur, it will be important in a pilot scale study to determine whether any vaporized explosives can be detected in the exhaust gases. Costs for treatment can vary from $100,000/year to $2,000,000/year depending on the water content of the slurry that is incinerated. In addition to incineration, acetone extraction, gamma irradiation, wet air oxidation, and water extraction tests were conducted and results reported in this document. Of the five procedures tested only incineration and acetone extraction proved effective in removing contaminants from sediments. Incineration equipment is available and pilot tests were recommended.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W06-Nitrated Aromatics and Aliphatics	121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
	118-96-7	Trinitrotoluene (TNT)
	479-45-8	Trinitrophenylmethylnitramine (tetryl)
W10-Non-Volatile Metals	7440-47-3	Chromium
W11-Volatile Metals	7439-92-1	Lead
W12-Other Inorganics	7440-43-9	Cadmium
	COD	Chemical Oxygen Demand

NOTE: Quality assurance of data may not be appropriate for all uses.

Incineration of Lagoon 9 Sediment Explosives Levels

		Concentration in Dry Sediment			
Temperature (°C)	Time (min.)	TNT (µg/g)	RDX (µg/g)	Tetryl (µg/g)	COD (µg/g)
No heat		424,000	159,000	15,800	206,000
200	5	10,000	< 1	114	124,500
	30	1,500	< 1	< 0.3	116,500
	60	1,350	< 1	< 0.3	149,200
300	5	< 2	< 1	< 0.3	55,200
	30	< 2	< 1	< 0.3	52,300
	60	< 2	< 1	< 0.3	30,000
500	5	< 2	< 1	< 0.3	5,900
	30	< 2	< 1	< 0.3	2,190
	60	< 2	< 1	< 0.3	1,280
700	5	< 2	< 1	< 0.3	8,720
	30	< 2	< 1	< 0.3	1,310
	60	< 2	< 1	< 0.3	2,320
900	5	< 2	< 1	< 0.3	12,200
	30	< 2	< 1	< 0.3	2,410
	60	< 2	< 1	< 0.3	1,670

Note: This is a partial listing of data. Refer to the document for more information.

NOTE: **Quality assurance of data may not be appropriate for all uses.**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Thermal Treatment - Circulating Bed Combustion (CBC)

Media: Soil/generic

Document Reference: GA Technologies, Inc. "PCB Destruction Facility Circulating Bed Combustor." Technical report prepared for U.S. EPA. 24 pp. December 1985.

Document Type: Contractor/Vendor Treatability Study

Contact:
Hiroshi Dodohara
Ogden Environmental Services, Inc.
P.O. Box 85178
San Diego, CA 92138-5178
619-455-2383

Site Name: Gulf Oil Corp., Berkley Heights, NJ (Non-NPL)

Location of Test: Berkley Heights, NJ

BACKGROUND: This treatability study reports on an evaluation of a pilot-scale, transportable, circulating bed combustor (CBC) for the incineration of PCB contaminated soils. This May 1985 test was for a demonstration to support a permit application for operation in California.

OPERATIONAL INFORMATION: The CBC demonstration utilized a spiked soil (10,000 ppm PCB concentration) at a feed rate of 400 pounds per hour and a CBC operating temperature of 1800°F. No information was provided on the soil. Three four-hour runs were completed; however, because problems occurred in the sampling of particulates in the initial test, a fourth abbreviated run of two hours was conducted solely for collecting a particulates sample. Three supplementary runs were conducted to evaluate low combustion temperatures (1625°F) and to incinerate PCB-contaminated soil. Feed soil, fly ash, and bed ash were sampled and analyzed. Stack emissions samples were collected for particulates, semi-volatile organics, and volatile organics.

PERFORMANCE: Destruction Removal Efficiencies (DREs) ranged from 99.9999% to 99.995% for PCB except for 1 run which resulted in a 99.82% efficiency. No significant PCB stack emissions were indicated. Particulate stack emissions during one test did not meet the standard for stationary air point sources. High particulate emissions were attributed to a high process air supply inadvertently applied to the air bag filtration unit. Another significant test value was the residual dioxin and furan in the treated soil. High values of 1.33 ppb for dioxins and furans were indicated in the fly ash.

Several operational problems were reported. The damp, irregularly shaped soil feed material used during the trials clogged the transfer ducts in the unit. Agglomeration of the soil also occurred in the combustor bed, affecting mixing efficiency with direct reduction in the combustion efficiency.

Other problems occurred with the stack sampling method. During one stack sampling sequence, fly ash was inadvertently dispersed throughout the operating bay, resulting in the evacuation of the entire office/pilot plant building. Siloxanes were present in the stack gas stream and interfered in the laboratory procedures to analyze the stack gas samples. However, the siloxanes may have been from silicone sealant which was used to install an in-line oxygen monitor, or from silicone rubber sealants in the sampling trains or similar sources. The demonstration trial runs and the supplementary tests indicated that the formation of agglomerates affected the combustion efficiency of the CBC unit, and increased the emission of products of incomplete combustion (PICs).

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Aromatic Compounds	TOT-TCB	Total Trichlorobenzenes
W02-Dioxins/Furans/PCBs	11096-82-5 12672-29-6	PCB 1260 PCB-1248

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-9 **Document Number: EUXM**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Immobilization - Cement Solidification

Media: Soil/Sand and Silt

Document Reference: Firestone Resource, Inc. (Three Documents). "Soil Stabilization Pilot Study, United Chrome NPL Site, Corvallis, Oregon" and "Quality Assurance/Quality Control Plan United Chrome NPL Site Pilot Study" and "Health and Safety Program, United Chrome NPL Site Pilot Study." Technical reports prepared for U.S. EPA - Region 10 and DEP of Oregon. Approximately 45 pages. February 1987.

Document Type: Contractor/Vendor Treatability Study

Contact:
John Barich
U.S. EPA - Region 10
1200 Sixth Avenue
Seattle, WA 98101
206-442-8562

Site Name: United Chrome, OR (NPL)

Location of Test: Corvallis, OR

BACKGROUND: This document is a project plan for a pilot study at the United Chrome NPL site, Corvallis, Oregon and includes the health and safety and quality assurance/quality control plans. The plan reports results of a bench-scale study of the treatment process as measured by the Toxicity Characteristic Leaching Procedure (TCLP) test. The purpose of this study, conducted by Firestone Resources Inc., was to evaluate the effectiveness of soil stabilization technologies to reduce the leaching of heavy metals and to "pretreat" contaminated soils for subsequent off-site management.

OPERATIONAL INFORMATION: The data available from this 1985 study are bench scale data involving 1400 pounds of soil from the Western Processing NPL site which was generated to support the proposal/work plan for the United Chrome NPL site. Three commercial soil stabilization vendors submitted to EPA 14 stabilized soil cylinders representing the "best achievable performance" of their technology. One of the bench-tests was performed by Firestone Resources, Inc. (FRI). The FRI treatment process consisted of using an inorganic polymer with cement that was applied to the excavated site soil. The extraction protocol used in the analysis was TCLP, and both treated and untreated soil were analyzed. Region 10 confirmed with these bench tests that soil stabilization as performed by these vendors is effective in reducing leach rate of heavy metals in sands/silt matrices with little organic co-contamination.

Contained in the document is site description data, work plan description data, and a proposed sample analysis plan.

The QA/QC plan for the pilot test is an attachment to the first volume of the study, and is extensive in the referenced methodology.

PERFORMANCE: The bench tests indicated reduction of heavy metal leachate concentrations to low levels as measured by TCLP procedures. The results of the FRI test are shown in the bottom table. Through groundwater modeling using as inputs the reductions in leachate strength as measured by these tests, soils stabilization was demonstrated to be capable of achieving water quality criteria at the Western Processing test site. Pilot demonstration of this treatment process is planned for the United Chrome NPL site.

CONTAMINANTS:

Treatability Group	CAS Number	Contaminants
W10-Nonvolatile Metals	7440-39-3	Barium
	7440-47-3	Chromium
	7440-50-8	Copper
	7440-02-0	Nickel
W11-Volatile Metals	7440-43-9	Cadmium
	7439-92-1	Lead
	7440-66-6	Zinc

TCLP Leachates From the Western Processing

Contaminant	Soil Leachate	Stabilized Soil	Percent Reduction
Zinc	123,700	38.5	99.97%
Lead	12,115	15.5	99.87%
Barium	1,165	ND	100.00%
Copper	227.5	32	85.93%
Nickel	107	ND	100.00%
Chromium	50	35	30.00%
Cadmium	17	0.4	97.65%

Notes:
a) All concentration in µg/l
b) ND - Not Detectable
c) This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-874 **Document Number: EUXT**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process:	**Physical/Chemical - Dechlorination**
Media:	Soil/Generic
Document Reference:	U.S. EPA. "Preliminary Report on Treatment/Detoxification Alternatives for PCBs and Chlorinated Organics." U.S. EPA ORD, HWERL. Cincinnati, Ohio. 31 pp. September 1985.
Document Type:	EPA ORD Report
Contact:	Charles Rogers , U.S. EPA, ORD-HWERL 26 W. Martin Luther King Dr. Cincinnati, OH 45268 513-569-7757
Site Name:	Manufactured Waste (Non-NPL)
Location of Test:	Buffalo, NY

BACKGROUND: The EPA Hazardous Waste Engineering Research Laboratory (HWERL) report summarizes the development of systems to dechlorinate polychlorinated biphenyls (PCBs), chlorinated dibenzo-p-dioxins (PCDDs) and chlorinated dibenzofurans (PCDFs) using a series of reagents prepared from alkali metals and polyethylene glycols (KPEG).

OPERATIONAL INFORMATION: The data for this document are pilot-scale data for the KPEG-350 slurry process and bench-scale data with various reagents for the slurry.

The pilot-scale slurry process was tested on a Buffalo, NY PCB contaminated site on July 15-20, 1985. The slurry reactor was a 55-gallon metal drum equipped with a lid, electric heating tape and a rocking mechanism that mixed reagent into soil. The original PCB concentration in soil ranged from 22-66 ppm. Approximately 150 lbs. of soil were added to the reactor along with 50 lbs. of reagent. The treatment time ranged from 2-2.5 hours at temperatures of 75°-100°C. PCBs were reduced from 22-66 ppm to less than 1 ppm after 2.5 hours of reaction with more than 90% of the reagent recovered for reuse.

The bench-scale data included several of the tests conducted on the effects of radio-frequency (RF) heating on the in-situ process. The document reports that RF heating of the soil was effective.

PERFORMANCE: The report indicates PCBs and dioxin concentrations can be reduced to less than 1 ppm and 1 ppb respectively by the slurry process. The document concludes that the in-situ process under ambient conditions is not as effective as the slurry process in the destruction of PCB- or PCDD-contaminated soils. It should also be noted that the document does not report any analysis on transformation products. This needs to be addressed, because when chemically altering PCBs, it is necessary to know what the transformation products are and their potential toxicities.

Costs of the process are estimated at $100 to $300/ton with the in-situ cost being higher due to reagent loss. The document reports on some methodology, procedures, and QA/QC protocols and indicates gas chromatograph/mass spectroscopy as the primary method of analysis. Laboratory QA/QC is not discussed in detail.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02-Dioxins/Furans/PCBs	1336-36-3	Total PCBs

NOTE: Quality assurance of data may not be appropriate for all uses.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Thermal Treatment - Rotary Kiln Incineration

Media:	Soil/Sandy
Document Reference:	AFESC, Tyndall AFB. "Full Scale Rotary Kiln Incinerator Field Trial: Phase I, Verification Trial Burn on Dioxin/Herbicide Orange Contaminated Soil." Internal technical report. 21 pp. Undated.
Document Type:	Contractor/Vendor Treatability Study
Contact:	Major Terry Stoddart U.S. DOD/AFESC Bldg. 1117 Tyndall Air Force Base, FL 32403 904-283-2949
Site Name:	Naval Construction Battalion Center, Gulfport, MS (Non-NPL - Federal facility)
Location of Test:	Gulfport, MS

BACKGROUND: This treatability study reports on the results of one of a series of field trials using various remedial action technologies that may be capable of restoring Herbicide Orange (HO)/Dioxin contaminated sites. A full-scale field trial using a rotary kiln incinerator capable of processing up to 6 tons per hour of dioxin contaminated soil was conducted at the Naval Construction Battalion Center, Gulfport, MS.

OPERATIONAL INFORMATION: Concentrations of HO on the site range from less than 0.1 ppb to over 500 ppb. It was estimated that a total of 11,000 tons of sandy or sandy loam soils contaminated with HO could be excavated and treated. The ENESCO mobile incinerator used in the test was capable of treating 100 tons of dioxin contaminated soil daily. The system successfully demonstrated 99.9999% Destruction Removal Efficiency (DRE) for PCB and Dioxin surrogates. In the incinerator, the soil was heated to 1000-1800°F in the rotary kiln which burned or volatilized all the gases. The gases were then drawn into a secondary combustion chamber (SCC) operated at 2000-2400°F for 2.2 seconds in an excess O_2 atmosphere to ensure complete combustion.

The residence time of the contaminated soil in the rotary kiln could be varied from 30 to 60 minutes by altering the kilns' rotation speed and/or the angle of attack. Air pollution control equipment on the system included cyclones for particulate control, a packed tower, a scrubber and a 35 foot stack. The packed tower removed HCL from the gas stream. The scrubber was designed to remove additional HCL and larger particulates (>3 microns).

PERFORMANCE: The trial burns were structured to evaluate system performance at various feed rates to ensure the mobile incinerator could be operated over a range of conditions with minimal environmental impacts. A total of five individual tests were conducted with contaminated soil feed rates ranging from 2.6 to 6.3 tons/hour. The unit would be brought to steady state temperatures and the sampling of the feedstock, treated soil and stack gases would be initiated. The "running time" of each test was dictated by the time required to collect a stack gas sample. The results of five different trial runs revealed that the incinerator is capable of removing dioxin and HO from the soil matrix to concentrations not detectable at 10 µg/kg (10 ppb). The results of a test run are shown in the table on the following page. The only operational problem resulted from wet soil from heavy rains. Soil drying would solve the problem.

EPA dioxin protocols from SW 846 were followed. These tests were considered successful and follow-up tests on incinerator reliability, maintainability, and cost effectiveness are planned. The treated soils should be delistable under RCRA based on the data.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02-Dioxins/Furans/PCBs	93-76-5	2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)
	94-75-7	2,4-Dichlorophenoxyacetic acid (2,4-D)
	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin
	F1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-furan
	OCDD	Octachlorobenzodioxins
W03-Halogenated Phenols, Cresols and Thiols	95-95-4	2,4,5-Trichlorophenol
	34DCP	3,4-Dichlorophenol

Note: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

Results of Chemical Analyses of Soil Treated in Rotary Kiln (Concentration as µg/kg)

Analyte	Test 1 2.82 tons/hr)		Test 2 (3.64 tons/hr)		Test 3 (3.71 tons/hr)		Test 4 (5.22 tons/hr)		Test 5 (6.31 tons/hr)	
	Feed	Treated	Feed	Treated	Feed	Treated	Feed	Treated	Feed	Treated
2,4,D	56,000	ND (20)	3,300,000	ND (20)	120,000	ND (20)	23,000	ND (20)	400,000	ND (20)
2,4,5-T	100,000	ND (2)	510,000	ND (2)	220,000	ND (2)	47,000	ND (2)	840,000	ND (2)
2,4,5-Trichorophenol	1,600	ND (1600)	3,700	ND (1600)	3,600	ND (1600)	8,000	ND (1600)	5,700	ND (1600)
3,4-Dichlorophenol	ND(330)	ND(330)	ND(330)	ND(330)	ND(330)	ND(330)	ND(330)	ND(330)	370	ND(330)
TCDD	32.1	ND (.0015)	54.2	ND (.0015)	38.0	ND (.00089)	45.8	ND (.0022)	60.6	ND (.0025)
OCDD	0.70	0.0024	0.64	0.00437	0.72	0.0193	0.80	0.0227	1.2	0.0116
TCDF	0.45	ND (.00085)	0.49	0.0129	0.58	0.0160	0.66	0.0067	1.2	0.0108

ND = Not Detected At The Indicated Limit

NOTE: **Quality assurance of data may not be appropriate for all uses.**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Thermal Treatment - Rotary Kiln

Media: Soil/Generic

Document Reference: PEI Associates, Inc. "BDAT Incineration of CERCLA SARMS at the John Zink Company Test Facility (Final Project Report)." Technical report prepared for U.S. EPA, ORD, HWERL, Cincinnati, OH. 375 pp. November 1987.

Document Type: EPA ORD Report

Contact:
Robert Thurnau
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HWERL-ORD
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Cincinnati, OH 45268
513-569-7629

Site Name: BDAT SARM-Manufactured Waste (Non-NPL)

Location of Test: ORD-Edison, NJ

BACKGROUND: This report presents the results of a treatability study of rotary kiln incineration of a synthetic "Superfund soil" bearing a wide range of chemical contaminants typically occurring at Superfund sites. This surrogate soil is referred to as a synthetic analytical reference matrix (SARM), and was composed of clay, sand, silt, topsoil, and gravel. Two concentrations of contaminants were added to this material to produce SARM I and SARM II; volatile and semivolatile organics (3000 ppm in SARM II and 30,000 ppm in SARM I), and metals (1000 ppm in SARM I and II).

OPERATIONAL INFORMATION: Three 4-hour test burns were conducted on each SARM at the John Zink pilot plant facility in Tulsa, Oklahoma using a rotary kiln incineration system capable of handling 1000 lb/hr of low BTU solids. The runs were conducted on September 16-18, 1987. The temperature and feed rates were reasonably close to the goals of 1800° F in the kiln, 2000° F in the secondary chamber, and nominal feed rates of 1000 lb/hr. Excess air was maintained at about 3% in the kiln and about 5% in the secondary. Emissions of O_2, CO_2, and CO were steady throughout the tests.

PERFORMANCE: The contaminant concentrations in the ash, scrubber water, and flue gas were measured to evaluate the performance of the treatment. Little or no volatiles were measured in the ash, except for acetone and phthalate, and these appear to be due to sample contamination. Metal concentrations in the ash were unexpectedly low (50 to 80% lower than in the feed). As expected, cadmium was at least 99.9% lower in the ash, due to volatilization. Only arsenic concentrations increased in the ash (more than double the concentrations in the feed). The scrubber water was essentially free of all organics, and contained only low ppm concentrations of metals. Critical emission parameters (oxygen, HCl, and CO) were within RCRA allowable limits. The DRE performance standard of 99.99% was achieved for the designed critical principal volatile organic contaminants for each SARM type. The DRE for the principal semi-volatile organic contaminants show that anthracene was effectively destroyed. DRE data for bis(2-ethylhexyl)phthalate showed three runs meeting the 99.99% criteria.

The document discusses QA/QC procedures in detail.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Aromatic Compounds	108-90-7	Chlorobenzene
W03-Halogenated Phenols, Cresols and Thiols	87-86-5	Pentachlorophenol
W04-Halogenated Aliphatic Solvents	107-06-2 127-18-4	1,2-Dichloroethane Tetrachloroethene
W07-Heterocyclics and Simple Aromatics	100-41-4 100-42-5 1330-20-7	Ethylbenzene Styrene Xylenes
W08-Polynuclear Aromatics	120-12-7	Anthracene
W09-Other Polar Organic Compounds	67-64-1 117-81-7	Acetone Bis(2-ethylhexyl)phthalate
W10-Halogenated Non-Polar Aromatic Compounds	7440-02-0 7440-47-3 7440-50-8	Nickel Chromium Copper
W11-Halogenated Non-Polar Aromatic Compounds	7439-92-1 7440-43-9 7440-66-6	Lead Cadmium Zinc

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-41 Document Number: EUZM

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: **Physical/Chemical - In-situ Soil Washing**

Media: Soil/Sandy

Document Reference: Science Applications International Corporation. "Treatment of Contaminated Soils with Aqueous Surfactants (Interim Report)." and "Project Summary: Treatment of Contaminated Soils with Aqueous Surfactants." Prepared for U.S. EPA, HWERL, ORD. 46 pp. December 1985.

Document Type: EPA ORD Report

Contact:
Richard Traver
U.S. EPA, ORD
HWERL - Releases Control Branch
Woodbridge Avenue
Edison, NJ 08837
201-321-6677

Site Name: Manufactured Waste (Non-NPL)

Location of Test: HWERL/EPA ORD Cincinnati, OH

BACKGROUND: This treatability study reports on the results, conclusions and recommendations of a project performed to develop a technical base for decisions for the use of surfactants in aqueous solutions to wash soils in-situ. The study reports on the selection of soil and contaminants, the test equipment and methods, the results of the various surfactant concentrations tested and the results of tests to remove the surfactants from the leachate.

OPERATIONAL INFORMATION: Aqueous nonionic surfactants, high boiling point crude oil, PCBs and chlorophenols were selected for testing. A fine to coarse loamy soil with 0.12 percent TOC by weight and permeability of 10^{-3}cm/s was selected for testing. Shaker table partitioning experiments were conducted to determine the minimum surfactant concentration required to accomplish acceptable soil cleanup. This was done for each of the selected contaminants. The soil was spiked and packed in a 3 inch by 5 ft. column for washing. Recycling of washing solution was tested and cleaning of the contaminants from the surfactant solution was tested.

PERFORMANCE: The extent of contaminant removal from the soil was 92 percent for the PCBs, using 0.75 percent each of Adsee 799 (Witco Chemical) and Hyonic NP-90 (Diamond Shamrock) in water. For the petroleum hydrocarbons, the removal with a 2 percent aqueous solution of each surfactant was 93 percent. Water alone removed all but 0.56 percent chlorophenol after the tenth pore volume of water. Leachate treatment alternatives of foam fractionations, sorbent adsorption, ultrafiltration and surfactant hydrolysis were tested in the laboratory. The tests were able to concentrate the contaminants in the wastewater to facilitate disposal, and clean the water enough to allow for reuse or disposal in a publicly owned treatment works. The study recommends further tests on other surfactants in particular their amenability to separation and reuse. Report concludes that the use of aqueous surfactants is a potentially useful technology for in-situ cleanup of hydrophobic and slightly hydrophilic organic contaminants in soil.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02-Dioxins, Furans,PCBs	1336-36-3	Total PCBs
W03-Halogenated Phenols, Cresols and Thiols	87-86-5	Pentachlorophenol (PCP) Cresols, Thiols

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-32 **Document Number: EUZU**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Physical/Chemical - Soil Washing

Media:	Soil/Sandy
Document Reference:	Summary report. "Harbauer Soil Cleaning System." 10 pp. Received at U.S. EPA Headquarters on November 20, 1987.
Document Type:	Contractor/Vendor Treatability Study
Contact:	W. Werner, President Harbauer, Inc. Berlin, W. Germany
Site Name:	Pintsch Oil Site (Non-NPL)
Location of Test:	Berlin, West Germany

BACKGROUND: This document reports on the use of a soil cleaning system to remove contaminants from various types of soils by washing and concurrently vibrating the soils to force the contaminant into the liquid phase. The system was developed by Harbauer and is being used in Berlin, Germany at a site contaminated with waste oils.

OPERATIONAL INFORMATION: The contaminated soil is mixed with the extractant liquid and introduced into a decontamination chamber. The chamber contains a device resembling a giant auger to which mechanical energy is applied axially in the form of vibrations. Separation is achieved continuously as the contaminated soil is moved through the system. A vibrating system was utilized as it allows for control of process conditions. The two most important parameters affecting system performance are residence time and the energy density of the vibrations. Residence time is varied by controlling the rotation speed of the auger which moves the material through the chamber. Energy density is controlled by altering the frequency and amplitude of the vibrations. There are four basic process parameters that must be optimized or controlled for a successful cleanup. They are: 1) producing a stable soil/liquid suspension, 2) extraction of the pollutants through the use of mechanical energy, 3) separation of the soil/liquid phases after extraction and 4) separation of the pollutant from the water phase and reuse of the extractant. The system is closed but no information was provided on system capacity. No QA/QC plan is contained in the document. No site specific information on the amount of soils requiring treatment or contaminant levels was provided. Dirty water from the soil washing operation at the Berlin site is incorporated into the overall groundwater cleanup process. This water meets effluent standards and may be released directly into neighboring waterways.

PERFORMANCE: The current state of the art allows for use of this technique in 0.06 mm to 0.6 mm particle size range. Research is being conducted to extend the technique down to the 0.006 mm particle size range to clean clay and other fine materials. Tests were conducted on a variety of different soils (sandy, silt and clay) contaminated with organic petroleum product, phenol chloride, PAH, PCB and cyanides. Removal efficiencies ranged from 84% to 100%. Clay soil had the lowest removal efficiency. The bottom table shows the results of tests on contaminated clay soil. The technique appears to remove various contaminants from the soil, however, no information is provided on the amount of contaminant the water extraction process alone removes versus the amount of contaminant removed by the energy introducedinto the system. No results were provided on the effect of increasing the energy density on contaminant removal efficiency.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02-Dioxins, Furans,PCBs	1336-36-3	Total PCBs
W08-Polynuclear Aromatics	TOT-PAH	Total Polycyclic Aromatic Hydrocarbons
W09-Other Polar Compounds	108-95-2	Phenol
W13-Other Organics	TEH	Total Extractable Hydrocarbons
	TOC	Total Organic Carbon

Results of Soil Washing Tests on a Clay Soil

Pollutants	Input Pollutant Level (mg/kg)	Remaining Pollutant Level (mg/kg)	Washing Success % Removed
Total Organics	4440	159	96.4
Petroleum Extract Total Phenol	165	22.5	86.4
PAH	948	91.4	90.4
EOX (mgCl-/kg)	33.5	ND	100
PCB	11.3	1.3	88.3

ND = None Detected

Note: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-26 **Document Number: EVAR**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: **Physical/Chemical - Reduction/Oxidation**

Media: Soil/Generic

Document Reference: Smith, D.L. and I.H. Sabberwal. "On-site Remediation of Gasoline-Contaminated Soil." 15 pp. Technical paper presented at the International Congress on Hazardous Materials Management, Chattanooga, TN, June 8-12, 1987.

Document Type: Conference Paper

Contact:
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Site Name: Soil Treatment Project, Southern California (Non-NPL)

Location of Test: Los Angeles, CA

BACKGROUND: This treatability study reports on the results of tests aimed at treating gasoline contaminated soils at seven different sites using hydrogen peroxide to oxidize gasoline constitutents to CO_2 and H_2O in the presence of a proprietary synthetic polysilicate catalyst.

OPERATIONAL INFORMATION: The author reviews the magnitude of the contamination problems associated with leaking underground storage tanks with emphasis on problems in California. The use of hydrogen peroxide to oxidize hydrocarbons is then discussed along with its attributes (no hazardous residue formation) and its drawbacks (slow reaction time oxidizing saturated hydrocarbons). A table showing the ability of H_2O_2 to react with various classes of compounds is included in the document along with a table showing the various types of organic constituents present in gasoline. The authors discuss the mechanism whereby a patented synthetic polysilicate named "Landtreat" is used to enhance the H_2O_2 oxidation of soils contaminated with gasoline. Basically the polysilicate acts as a catalyst to enhance the oxidation of the organic species. Through a high-temperature, high-vacuum process, Frankel defects are created in the matrix of the polysilicate. These defects become active sites which increase the absorptive capacity of the "Landtreat". UV light also enhances the reaction rate. Furthermore, the active sites on the "Landtreat" react with cations, specifically heavy metals, converting them to metal silicates which pass the EP toxicity test.

The soil to be treated is excavated, mixed with "Landtreat" and sprayed with a solution of H_2O_2 in water. The soil is mixed with a backhoe, frontloader or similar earth mover to ensure adequate contact. QA/QC and Health and Safety procedures are discussed in the document. Cost for treating the soil ranges from $70-$130 per cubic yard.

PERFORMANCE: The information presented in the report are from actual soil treatment projects performed in southern California. In general, between 300 and 1500 cubic yards of soil were treated. Dry sandy and sandy clay soils were reported. Project completion time took from 3 to 7 days work onsite excluding excavation, lab analysis, and backfilling. Average treatment efficiencies for total petroleum hydrocarbons (TPH) ranged from 96% to in excess of 99% depending on the site characteristics. The results of a seven day test at one site and the amount of total petroleum hydrocarbons removed is shown in Table 1. The results indicate that the oxidation of hydrocarbon contaminated soils by H_2O_2 in the presence of a synthetic catalyst is a technically viable soil remediation method.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Nonpolar Aromatic Compounds	108-90-7	Chlorobenzene
W04-Halogenated Aliphatic Compounds	106-93-4	Ethylene dibromide
W07-Simple Nonpolar Aromatics and Heterocyclic	71-43-2	Benzene
	108-88-3	Toluene
	95-47-6	O&P-Xylene
	100-41-4	Ethylbenzene
	108-38-3	M-Xylene
W11-Volatile Metals	7439-92-1	Lead
W13-Other Organics	TOT-PETROL	Total Petroleum Hydrocarbons

NOTE: Quality assurance of data may not be appropriate for all uses.

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Total Petroleum Hydrocarbon Concentrations at Site 6 Before and After Treatment

Untreated Soil (ppm)	Treated Soil* (ppm)
6,700	6.9
4,300	<2.0
1,803	15.8
8,884	15.2
1,663	<2
40,302	6
71.7	4

* There is no direct correlation between treated and untreated soil for the results shown above. Untreated soil samples were taken at various depths during excavation and the treated samples were taken from various parts of the treatment pile subsequent to mixing and treatment.

Note: This is a partial listing of data. Refer to the document for more information.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Biological - Aerobic

Media: Soil/Generic

Document Reference: Koppers Co., Inc. "Evaluation of an Engineered Biodegradation System at the Nashua, N.H. Site." Technical report prepared for Keystone Environmental Resources, Inc. Approximately 106 pages. April 1987.

Document Type: Contractor/Vendor Treatability Study

Contact:
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1050 Connecticut Avenue, NW, Suite 300
Washington, DC 20036
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Site Name: Nashua Site NH (NPL)

Location of Test: Nashua, NH

BACKGROUND: The treatability study report presents the results of both laboratory and field studies conducted by Koppers on soils from the Nashua, N.H., NPL site. The purpose of these studies was to provide the necessary data to evaluate a full-scale design for the Engineered Biodegradation System (EBDS) to treat wood preservative residues found in the soils at this site.

OPERATIONAL INFORMATION: The laboratory bench-scale studies consisted of a soil pan study and a soil column study. The soil pan study evaluated the influence of soil moisture, nutrients, and level of waste application on biodegradation. The soil column study evaluated the mobility of waste constituents in soil, air, and water.

In the pilot-scale field study, which was performed onsite, the treatment unit with an area of 10,000 sq ft was loaded with 1 foot of contaminated soil. The soil from the Nashua site was not characterized. Cow manure, lime, water, and fertilizer were added, and the mixture was rototilled to maintain aerobic conditions. The test was run for approximately 6 months.

PERFORMANCE: Highest initial contaminant concentrations were 7707 ppm for oil and grease, 2143 ppm for PAH, and 133 ppm for PCP. In the field investigation, over 80% of PCP and napthalene, and 90% of the PAHs were chemically/biologically degraded by the pilot-scale EBDS. The pilot-scale aerobic design was applied to the soils utilizing operating parameters (i.e., moisture content, additive agents like fertilizer and lime) established from the bench scale study. The EBDS unit promotes the growth of unspecified indigenous microorganisms to biodegrade contaminants.

Both the potential problems of fugitive emissions and leachate run-off were addressed in the pilot study design. Tests results for both of the potential problems showed that negligible amounts of runoff and fugitive emissions were generated. Bench-scale data and pilot-scale data is available in the document.

The study does not report the analysis for potential toxic intermediates (transformation products) that may be produced from the microbial degradation. Further, no QA/QC protocols are reported in the document. The document reports total waste analysis and toxicity characteristic leaching procedure (TCLP) extract analysis data. There were no influent TCLP analyses to match the effluent TCLP concentrations remaining in the soil.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W03-Halogenated Phenols, Cresols, Thiols	87-86-5	Pentachlorophenols
W08-Polynuclear Aromatics	TOT-PAH	Total Polycyclic Aromatic Hydrocarbons
W13-Other Organics	TOT-OIL	Oil and Grease

NOTE: Quality assurance of data may not be appropriate for all uses.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: **Physical/Chemical - UV Photolysis**

Media: Soil/Generic

Document Reference: International Technology Corp., AFESC, EG&G Idaho, Inc. "Technology Demonstration of a Thermal Desorption/UV Photolysis Process for Decontaminating Soils Containing Herbicide Orange."Prepared for EG&G Idaho. 14 pp. Technical report.

Document Type: Contractor/Vendor Treatability Study

Contact:
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Site Name: NCBC Gulfport, MS; Johnston Island; and Guam (Non-NPL)

Location of Test: Gulfport, MS and Guam

BACKGROUND: This treatability study report presents the results of laboratory and field tests on the effectiveness of a new decontamination process for soils containing 2,4-D/2,4,5-T and traces of dioxin. The process employs three operations, thermal desorption, condensation and absorption of contaminants into a solvent and photo decomposition. Bench-scale tests were conducted to establish the relationships between time and temperature and treatment efficiency. A pilot-scale (100 lbs/hr) system evaluation was conducted at two sites to evaluate system performance and develop scale-up information.

OPERATIONAL INFORMATION: The intent of the laboratory and pilot-scale tests was to reduce the combined dibenzo dioxin and furan constituents, which originate from Herbicide Orange (HO), to less than 1 ng/g. This level represents the anticipated soil cleanup criteria. The soils used had similar concentrations of HO contaminants, but were different types of soil. In the laboratory the contaminated soil is passed through thermal desorber and the off gases from the soils, including the contaminants, are passed through a scrubber that uses a hydrocarbon solvent. Contaminants dissolve in the solvent and the solvents are passed through a flow reactor which subjects the contaminant to UV radiation to decompose the contaminant molecules. Testing was conducted on soil samples from three HO contaminated sites; Johnson Island, Eglin AFB and NCBC in Biloxi, MS. The soils tested had 2,3,7,8-TCDD concentrations greater than 100 ng/g of soil and 2,4,-D/2,4,5-T levels greater than 1000 ng/g soil. Tests were run at three different temperatures and two different power levels using high intensity UV quartz mercury vapor lamps.

Pilot tests were conducted at the NCBC site using a rotary indirect calciner as the desorber, an off gas transfer and scrubber system and a photochemical reactor to irradiate the contaminants contained in the scrubber solution. A 1200-watt high intensity mercury vapor lamp was used to irradiate the contaminated scrubber solution. No QA/QC plan was contained in the document. No discussion of analytical techniques utilized to detect HO and associated compounds is contained in the paper. A detailed list of soil properties (particle size distribution, surface area, organic matter, etc.) from the three different sites is contained in the document.

PERFORMANCE: Laboratory studies revealed that thermal desorption/UV photolysis destroyed all compounds to below their analytical detection limit (which was generally less than 0.1 ng/g). The concentration of 2,3,7,8-TCDD was reduced from 200 ng/g to less than 1 ng/g. Insoluble brown tars (presumably phenolic tars) were deposited on the surfaces of the reactor vessel and lamp well. Reaction kinetics quantum yields and rate constants were determined. Pilot tests also produced soil containing less than 1 ng/g of 2,3,7,8-TCDD. The bottom table shows the results of the tests.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02-Dioxins/Furans/PCBs	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)

Effect of Treatment Conditions on Residual 2,3,7,8-TCDD During NCBC Pilot Thermal Desorption Tests

Test No.	Soil Feed Rate (kg/hr)	Residence Time[a] (min)	Soil Temperature (°C)	2,3,7,8-TCDD[b] (ng/g)	
				Initial	Residual
1	13.6	40	560	260	ND
2	13.6	40	560	272	ND
3	25	19	560	236	ND
4	44	10.5	560	266	ND
5	20	24	460	233	0.5

Notes: a)Soil residence time in heated zone.
b)Detection level for 2,3,7,8-TCDD was generally less than 0.1 ng/g with a range of 0.018 to 0.51 ng/g.
c)This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-43 **Document Number: EWGE**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: **Thermal Treatment - Circulating Bed Combustion (CBC)**

Media: Soil/Clayey

Document Reference: Ogden Environmental Services, Inc. "BDAT Treatability Data for Soils, Sludges and Debris From the Circulating Bed Combustion (CBC) Process." Technical report prepared for U.S. EPA. 31 pp June 1987

Document Type: Memo and Conference Paper

Contact:
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Tyndall Air Force Base, FL 32403
904-283-2949

Site Name: Circulating Bed Combustion Demonstration Facility (Non-NPL)

Location of Test: California

BACKGROUND: The two papers provide a general overview of the Ogden circulating bed combustion and summary data of both PCB laden soils for EPA-TSCA and a test on RCRA liquid organic wastes for the California Air Resources Board (CARB). This abstract will discuss the results of the PCB test, which was planned, monitored and approved by the EPA.

OPERATIONAL INFORMATION: The primary CBC components are the combustion chamber, hot cyclone collector, flue gas cooler, baghouse, and stack. Auxiliary systems include feeders (solids, liquids, sludges), forced-draft and induced-draft fans, ash conveyer, compressed air, cooling tower, and building ventilation. Operating parameters, schematic diagram and cost estimates are provided.

Atmospheric primary air is pumped into the lower portion of the combustion chamber where the bed material is fluidized by turbulent mixing of the air and solids. Larger solids gravitate downward to form a more dense fluidized bed in the lowest combustor zone. The forced-draft primary air carries smaller solids up to the top of the combustor. Secondary air is supplied to various locations in the combustion chamber to ensure complete combustion and minimize formation of nitrogen oxides (NO_x).

Auxiliary fuel and pressurized contaminated soil feed are individually introduced into the lower combustion chamber. Capability also exists to feed liquid wastes. Dry limestone sorbent is added to control gaseous emissions of sulfur, phosphates, chlorines, or other halogens.

Elutriated solids are separated from the flue gas by a hot cyclone and reinjected into the lower combustor using a proprietary non-mechanical seal. Injection, burning and reaction of fuel, contaminated soil feed, sorbent, and ash components are the inputs and outputs of a continuing chemical process which destroys the hazardous wastes.

A trial burn of PCB-contaminated soils was completed in GA Technologies transportable Circulating Bed Combustor (CBC). Over 4000 pounds of soil containing 1% PCB were treated in three identical 4-hour runs at 1800° F. The sampling and analysis and the resulting data were obtained in accordance with the QA/QC protocol of EPA. Third party sampling and analysis contractors were used (along) with on-site and in-lab observation by EPA.

PERFORMANCE: Destruction and removal efficiencies (DREs) were greater than 99.9999% and PCB levels in combustor ash were less than 200 ppb (see the table on the following page). No chlorinated dioxins or furans were detected in the stack gas, bed ash, or fly ash. In addition, no significant concentrations of the Products of Incomplete Combustion (PICs) were detected. Combustion efficiencies were greater than 99.9%, with CO concentrations less than 50 ppm and NO_x concentrations less than 75 ppm. Particulate emissions were generally below 0.08 grain/dscf and HCL emissions were maintained below 4.0 lb/hr by introducing limestone directly into the combustor. It is noted that PCB test data led to the first TSCA permit for transportable PCB incinerator operation in all 10 EPA regions.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02-Dioxins/Furans/PCBs	1336-36-3	Total PCBs

NOTE: **Quality assurance of data may not be appropriate for all uses.**

PCB Trial Burn Operational Data and Test Results

Parameter	TSCA Requirement	Test Number		
		1	2	3
Test Duration, hr	4	4	4	4
Operating Temperature, °F	--	1800	1800	1800
Soil Feed Rate, lb/hr	--	328	412	324
Total Soil Feed, lb	--	1592	1321	1711
PCB Concentration in Feed	ppm	11,000	12,000	9,800
DRE %	>99.9999	99.999995	99.999981	99.999977
PCB Concentration				
Bed Ash, ppm	<2	0.0035	0.033	0.186
Fly Ash, ppm	<2	0.066	0.0099	0.0032
Dioxin/Furan Concentration				
Stack Gas, ppm	--	ND[1]	ND	ND
Bed Ash, ppm	--	ND	ND	ND
Fly Ash, ppm	--	ND	ND	ND
Combustion Efficiency, %	>99.9	99.94	99.95	99.97
Acid Gas Release, lb/hr	<4.0	0.16	0.58	0.70
Particulate Emissions, grain/scf (dry)	<0.08	0.095[2]	0.043	0.0024
Excess Oxygen, %	>3.0	7.9	6.8	6.8
CO, ppm	--	35	28	22
CO_2, %	--	6.2	6.0	7.5
NO_x, ppm	--	26	25	76

1 ND = Not Detected

2 Derived from 2-hour makeup test

Note: This is a partial listing of data. Refer to the document for more information.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: **Thermal Treatment - Infrared**

Media: Soil/Generic

Document Reference: Shirco Infrared Systems, Inc. "Abstract On-site Incineration Testing of Shirco Infrared Systems Portable Demonstration Unit-Contaminated Soils Treatability Study." Prepared for Dakonta GmbH Hamburg and Ingelheim, West Germany, 3 pp. June 1987.

Document Type: Abstract

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Site Name: Boehringer's Lindane Facility (Non-NPL)

Location of Test: West Germany

BACKGROUND: In August of 1986, Shirco was contracted by Dekonta GmbH, a West German hazardous waste treatment company, to perform treatability studies at one of the largest dioxin-contaminated sites in the world. The Shirco Infrared process was selected by Dekonta after a two year study and evaluation of existing and emerging technologies for soils decontamination.

The West German hazardous waste management regulations, which are established and enforced on a state by state basis, differ somewhat from those in the U .S. Transportation of dioxin-bearing wastes, for instance, is strictly prohibited. Hence, mobile technologies offer distinct advantages for multiple site remediation.

OPERATIONAL INFORMATION: Tests were conducted using the Shirco Portable Demonstration Unit during the months of November 1986 and February 1987. Over 3000 kg of contaminated soil were processed in 100 hours of testing. Various operating condition's including soil contaminant level, feed rate, primary chamber temperature and residence time, co-flow and counterflow operation, and gas atmosphere (air vs. nitrogen) were tested to determine the effect on soils decontamination levels and exhaust gas emissions. The organic contaminants in the soils included dioxins, furans, chlorobenzenes, chlorophenols, 2,4,5-T, and hexachlorocyclohexanes. Contaminant concentrations on soils ranged from 4 to 7500 ppb for dioxins, 3 to 5700 for furans and from 33 to 16,600 ppm for chlorobenzenes. No QA/QC data was presented.

PERFORMANCE: Results of approximately 20 tests indicate exhaust gas concentrations of 2,3,7,8-TCDD from less than 20 pg/m^3 to 88 pg/m^3, whereas field "blanks" showed concentrations ranging from 33 pg/m^3 to 73 pg/m^3.

The source of the high blank concentrations is currently under investigation, therefore, the validity of the reported values cannot be established at present. A brief summary of the data is on the attached table.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Aromatic Compounds	108-90-7	Total Chlorobenzenes
W02-Dioxins/Furans/PCBs	HEPCDD	Total Heptachlorodibenzo-dioxin
	OCDF	Octachlorodibenzofurans
	OCDD	Octachlorodibenzo-dioxin
	PCDD	Total Pentachlorodibenzo-dioxin
	HEXCDD	Total Hexachlorodibenzo-dioxin
	TCDF	Total Tetrachlorodibenzo-furan
	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)
	TCDD	Total Tetrachlorodibenzo-dioxins
	HEPCDD	Total Heptachlorodibenzo-dioxin
	PCDF	Total Pentachlorodibenzo-furans
	HEXCDF	Total Hexachlorodibenzo-furans
	HEPCDF	Total Heptachlorodibenzo-furans

NOTE: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

West Germany Dioxin Test Summary Soil Feed and Ash Quality Data

Soil Identification	DIOXINS						FURANS					Chloro-benzenes
	2,3,7,8 TCDD[a]	TCDD	PCDD	HXCDD	HPCDD	OCDD	TCDF	PCDF	HXCDF	HPCDF	OCDF	
2 Feed (ppb)	6.7	6.7	4.0	17	50	202	--	3.1	9.4	14.6	35.3	58,000
2 Ash	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1,200
2 Feed (ppb)	4.4	6.0	18	121	340	2301	12	53	58	98	358	169,000
2 Ash (ppt)	ND	ND	ND	5.1	18	60	15	27	20	24	12	9,600
1 Feed (ppb)	24	33	36	115	292	7458	33	41	54	174	3151	242,000
1 Ash (ppt)	ND	ND	ND	ND	15	50	52	45	26	23	12	4,700
4 Feed (ppb)	38	42	41	109	280	5940	67	44	129	128	5660	33,000
4 Ash (ppt)	ND	ND	ND	17	6.8	15	125	111	58	34	12	16,000
6 Feed (ppb)	34	38	27	90	238	5160	49	34	80	106	4700	40,000
6 Ash (ppt)	ND	ND	ND	15	9.2	20	70	54	24	13	6.2	4,600
2 Feed (ppb)		NOT	YET		AVAIL ABLE							16,612,000
2 Ash (ppt)												11,000
1 Feed (ppb)		NOT	YET		AVAIL ABLE							16,526,000
1 Ash (ppt)												7,400

NOTE: ND = Not Detectable .
Detection Limits: a. 2,3,7,8 TCDD = 1-2 ppt
b. All others = 5 ppt
Primary Chamber Temperature: 1550-1650^{o}F
Solid Phase Residence Time: 15 minutes

NOTE: Quality assurance of data may not be appropriate for all uses.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Thermal - Rotary Kiln

Media: Soil/Clayey

Document Reference: Acurex Corp., Environmental Systems Divisions, Combustion Research Facility. "CRF Test Burn of PCB-Contaminated Wastes from the BROS Superfund Site." Approximately 300 pp. Prepared for U.S. EPA Office of Research and Development. March 1987.

Document Type: EPA ORD Report

Contact:
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New York, NY 10278
212-264-8216

Site Name: BROS Superfund Site (NPL)

Location of Test: Jefferson, AR

BACKGROUND: This report provides results of test burns at the EPA Combustion Research Facility on waste from Bridgeport Rental and Oil Service (BROS) Superfund site, NJ. The purpose of the study was to (1) determine if waste could be incinerated safely; (2) comply with the Toxic Substances Control Act (TSCA) regulations governing PCB-contaminated waste; and (3) determine if residuals could be classified as non-hazardous.

OPERATIONAL INFORMATION: Rotary kiln was cocurrent propane fired and had a maximum design capacity of 900°C (1650°F) with a gaseous residence time of 1.7 seconds for 10% excess O_2 in flue gas. Containerized solvents were fed in 1.5 gallon fiber packs using a ram feeder. Liquids and sludge were fed using a progressive cavity pump through a water-cooled lance. Air pollution control (APC) equipment included a venturi scrubber/quench with a 30 inch W.D. pressure drop followed by a packed tower scrubber. A backup dry air pollution control system was utilized to ensure ultimate emissions would be within the applicable regulatory limits. Scrubber system blowdown was directed to a chemical sewer, if non-hazardous, or stored in tanks for management at a RCRA facility, if hazardous. Waste included: lagoon surface oil, lagoon sludge, and soil. Average composition: 210-600 ppm PCB, low to 38% water, 23.2-10,000 Btu/lb. The soil was a clay mud containing rocks, grass, roots, and twigs.

Twelve tests were performed during 7/21/88 through 9/4/88 (test time was five weeks). Tests involved variation of: waste feed, kiln temperature, excess O_2, rotation time (solid retention time). The report provides specific information on unit design (schematic diagram included) and provides test data. Sampling and analysis and QA information is also provided.

PERFORMANCE: The PCB emission results are summarized in the table on the following page. The test failed to meet the TSCA regulations for 99.9999 percent destruction efficiency (DE) at the stack gas effluent as measured after the scrubber discharge flue gas. DE results ranged from 99.992 to 99.9998. On average DEs were highest for surface oil and lowest for the soil sludge mixtures. Data indicated no clear correlation between key process parameters and DE. Analysis indicates that a gas residence time of 2.0 seconds in the afterburner and a temperature of 1200°C would be required for this unit to achieve TSCA requirements. This is twice the residence time achieved in this test.

Scrubber blowdown PCB content was below detection levels (< 1 µg/L). Kiln ash was below detection level for PCBs except for ash from surface oil which tested at 2.55 µg/g. Particulate and HCL emissions were within regulatory limits. Metal concentrations in leachate samples from ash were below the EP toxicity limit.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W04-Halogenated Aliphatic Solvents	75-35-4	1,1-Dichloroethene
	78-87-5	1,2-Dichloropropane
	56-23-5	Carbon Tetrachloride
	79-01-6	Trichloroethene
	75-34-3	1,1-Dichloroethane
W07-Heterocyclics and Simple Aromatics	71-43-2	Benzene
	108-88-3	Toluene
	71-43-2	Benzene
W10-Non-Volatile Metals	7440-39-3	Barium
	7440-47-3	Chromium
W11-Volatile Metals	7439-92-1	Lead
	7440-38-2	Arsenic
W13-Other Organics	110-54-3	Hexane

NOTE: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

PCB Emission Rate and DE Summary

		Feed (Arochlor 1254)		Emission (Arochlor 1254) at scrubber discharge			
Waste Type	Test No.	Concentration (mg/kg)	Rate (mg/s)	Concentration (ng/dscm)	Rate (µg/s)	DE (percent)	Weighted average DE (percent)
Lagoon surface oil	1	282	1.38	207	0.097	99.9930	99.9944
	2	296	1.68	212	0.12	99.9929	
	3	280	1.85	180	0.060	99.9968	
Soil	1	67.3	0.834	32	0.0093	99.9989	99.9990
	2	167	2.02	39	0.011	99.9995	
	3	95.4	1.20	52	0.021	99.9983	
Sludge	1	250	2.77	9	0.0039	99.99986	99.9992
	2	250	2.46	42	0.019	99.99923	
	3	250	2.27	82	0.037	99.9984	
Soil plus sludge	1	78.6	0.913	49	0.021	99.9977	99.979
	2	120	1.39	73	0.031	99.9978	
	3	170	2.04	109	0.041	99.9980	

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Thermal Treatment - Pyrolysis

Media: Soil/Sandy

Document Reference: J. M. Huber Corp. "Advanced Electric Reactor (AER) for the Treatment of Dioxin-Contaminated Soils." 14 pp. February 1984.

Document Type: Memo

Contact:
James Boyd
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P.O. Box 2831
Borgen, TX 79007
806-274-6331

Site Name: J.M Huber Corp. - Borgen, TX (Non-NPL)

Location of Test: Borgen, TX

BACKGROUND: This newsletter reports on the Huber Technology Groups (HTG) high temperature advanced hazardous waste treatment technology capable of very high destruction and removal efficiencies of various hazardous wastes. This newsletter addresses the destruction of PCBs in an EPA certification test of the HTG Advanced Electric Reactor.

OPERATIONAL INFORMATION: The Advanced Electric Reactor of HTG is a high temperature electrically heated low gas flow reactor, capable of attaining temperatures of 4,000°F to 4,500°F under low flow conditions, which allows for relatively long residence times; i.e., 5 seconds. For comparison purposes, a rotary kiln has only a one to two second residence time. Soils can also be treated and after removal of contaminants they can be landfilled. The reactor can be connected to off-the-shelf stack gas cleaning equipment to ensure high removal of all pollutants. The reactor vessel uses nitrogen gas. Oxygen is absent from the combustion process thus preventing the formation of unwanted oxygen containing by-products, such as dioxin and furans. The system is mobile and was used in a PCB destruction test witnessed by the U.S. EPA and Texas Air Board. There is no discussion of the analytical techniques used to measure PCBs. No QA/QC discussion is included.

PERFORMANCE: The results of a trial burn run of the HTG Advanced Electrical Reactor in removing PCBs are shown in the table on the following page. Initial concentration of Arochlor 1260 was 3000 ppm. The Destruction Efficiencies were 99.9999% in all but one of the tests. Solid phase soil PCB concentrations were well below the 50 ppm level after treatment. No HCl, Cl_2, dioxins or furans were observed at the stack. Only trace NO_x and particulate levels were observed. Chlorine removal efficiency in the scrubber and carbon beds were greater than 99.999%. An accompanying document indicated that the reactor technique could also destroy dioxin contaminated material to below current detection levels. However, there were no detailed results of dioxin tests reported in the newsletter.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02-Dioxins/Furans/PCBs	11096-82-5	PCB-1260

NOTE: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

Summary of Results: EPA Certification Test

Run #	Date	Feed #/Min	R. Temp. (°F)	Total N_2 (scfm)	% Gas-Phase Cyclone (DE)	Control Stack (DRE)	Solid Phase PCBs, PPM Treated Feed
1	9/27/83	15.1	4100	147.2	99.99992	99.9999950	0.0005
2	9/28/83	15.7	4100	147.2	99.99992	99.9999994	$<$0.0005
3	9/29/83	15.7	4100	147.2	99.99960	99.9999980	0.0006
4	9/29/83	15.8	4100	147.2	99.99995	99.9999940	0.0010

NOTE: Quality assurance of data may not be appropriate for all uses.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: **Physical/Chemical - Low Temperature Thermal Stripping**

Media: Soil/Generic

Document Reference: Canonie Environmental Services Corp. "Soil Remediation and Site Closure McKin Superfund Site," Gray, Maine. Technical report of approximately 250 pp. prepared for U.S. EPA. July 1987.

Document Type: Contractor/Vendor Treatability Study

Contact:
U.S. EPA - Region I
John F. Kennedy Federal Bldg.
Room 2203
Boston, MA 02203
617-565-3715

Site Name: McKin Superfund Site, Gray, ME (NPL)

Location of Test: Gray, ME

BACKGROUND: This treatability study report describes soil remediation and site closure activities conducted at the McKin Superfund site in Maine. The work described in this report involves the removal of volatile organic compounds and petroleum residues from contaminated soils by low temperature thermal aeration in an enclosed environment. The report discusses the enclosed aeration process, impact of the operation on ambient air quality, effectiveness of the system, cleanup costs, and disposal of accumulated on-site materials used in the project.

OPERATIONAL INFORMATION: The soil aeration system utilized during the site cleanup consisted of a thermal dryer, a baghouse for control of particulate matter, a scrubber to remove water soluble gases, and a vapor phase carbon treatment system to remove organics from the vapor phase. Soils were screened to remove boulders and debris, and fed through the system a number of times via a conveyer to ensure complete aeration. Soil temperatures were maintained at 250 - 400°F to facilitate volatilization of organics. Soil was solidified with concrete after treatment. 11,500 cubic yards of soil were processed at the site. Soil types are discussed in reports on previous studies conducted on the site. Organic vapor concentrations were monitored at the site boundaries, periodic air quality monitoring was conducted at 10 nearby residences and high volume particulate sampling was conducted at the site. Ambient hydrocarbon levels were well below (between 0.002 to 0.01 ppm) the level established as a health standard (2 ppm).

During the pilot study, ambient particulate standards were exceeded on three occasions. Changes in the material handling system reduced fugitive dust emissions and allowed for the processing of 10,000 cubic yards of soils without further exceedences of the air quality standard for total solid particles. Various references are made to QA/QC and to the EPA standard methods for VOC analysis.

PERFORMANCE: The excavated/aerated soils from the site satisfy the performance standard specified in the site Record of Decision (ROD)(0.1 ppm of TCE). Concentrations of VOCs and petroleum products before and after treatment of soils are shown in the table on the following page.

Significant reduction in the levels of various contaminants before and after treatment are noted. Groundwater modeling demonstrated that groundwater criteria specified in the ROD were met. A detailed cost breakdown of the use of aeration to remediate soils contaminated with VOC and petroleum hydrocarbons is provided. Based on this data, the average cost for treating the soils at this Superfund site is $252 per cubic yard. Aeration was utilized to remediate contaminated soil and not violate ambient air quality criteria at this site.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Aromatic Compounds	95-50-1	1,2-Dichlorobenzene
W04-Halogenated Aliphatic Solvents	71-55-6	1,1,1-Trichloroethane
	75-35-4	1,1-Dichloroethene
	127-18-4	Tetrachloroethene
	79-01-6	Trichloroethene
W07-Heterocyclics and Simple Aromatics	71-43-2	Benzene
	100-41-4	Ethylbenzene
	108-88-3	Toluene
W08-Polynuclear Aromatics	1330-20-7	Xylene
	120-12-7	Anthracene
	91-20-3	Naphthalene
	206-44-0	Fluoranthene
	85-01-8	Phenanthrene
W09-Other Polar Organic Compounds	85-68-7	Butylbenzylphthalate
	78-59-1	Isophorone
W13-Other Organics	TEH	Total Extractable Hydrocarbons

NOTE: **Quality assurance of data may not be appropriate for all uses.**

Concentrations of VOCs and Petroleum Products Before and After Treatment of Soils

Compound	Pretreatment Soil Concentration (mg/kg)	Post-treatment Soil Concentration (mg/kg)
trans 1,1,-dichloroethane	0.11	ND .02
trichloroethene (TCE)	7.3	ND .02
1,1,1,-trichloroethene	0.13	ND .02
Toluene	35	ND 1.0
Xylenes	84	ND 1.0

ND - None detected at 0.2 or 1.0 ppm

Note: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Biological - Aerobic and Anaerobic

Media: Soil/Generic

Document Reference: NUS Corporation. "Leetown Pesticide Site Treatability Study." Four progress reports in internal memorandum form. 62 pp. (total). Written under EPA Contract. July 1986 - January 1987.

Document Type: Contractor/Vendor Treatability Study

Contact:
William Hagel
Regional Project Manager
U.S. EPA - Region III
841 Chestnut Street
Philadelphia, PA 19107
215-597-9800

Site Name: Leetown Pesticide Site, Leetown, WV (NPL)

Location of Test: NUS, Pittsburgh, PA

BACKGROUND: This document is composed of a series of progress reports pertaining to a bench-scale treatability study which utilized biodegradation to remediate pesticide contaminated soils (DDT and DDE) at the Leetown Pesticide NPL site. Treatment consisted of aerobic, anaerobic and fungal processes to biodegrade the DDT and DDE.

OPERATIONAL INFORMATION: Nutrients such as manure, sewage sludge and wood chips were added to the soils to promote the growth of microbes capable of degrading the pesticides. More than 400 biodegradation cells were used over 4 test periods. Efforts to control temperature, pH and moisture content were attempted during the study. One report states that DDT degradation appears to take place at 35° under anaerobic conditions and that DDE degradation takes place in acidic media. The microbes used in the test were not specified but are indigenous to the site. Baseline DDT and DDE levels were approximately 7,000 µg of DDT per Kg soil and 1000 µg of DDE per Kg of soil.

An extraction procedure with hexane done on the soil to analyze for DDT was criticized for being a quick and dirty extraction with no cleanup of the extract. Other concerns reported were strongly sorbed compounds may not be detected, interference from naturally occurring organic matter could skew the results and lack of standard analytical protocols could introduce extraneous variables into the data. Specific information pertaining to the quantity or type of contaminated soils was not included in the report.

PERFORMANCE: In December of 1986 an analysis of variance (ANOVA) of the results was conducted to determine if there is any statistically significant difference between the various samples collected from each of the different treatment cells and to determine if there is a significant difference in DDT and DDE concentrations from one cell treatment to the next. The ANOVA indicated there is no significant difference between the various cell configurations. Hence the average concentration calculated for each cell configuration is representative of the population mean. A review of the sampling data reported in the December 30th progress report suggests that anaerobic vessels operating under incubated conditions represented the best method of degrading DDT in the soils. The authors report that the indigenous microbial populations can be used to degrade DDT at the Leetown Pesticide Site. A preliminary estimate of the time for this process to reduce DDT plus DDE to desired action levels of 300 µg/kg of total DDT and metabolites was 8 months. Both DDT and DDE are degraded under anaerobic conditions, and anaerobic vessels operating under incubated conditions represent the best method of degrading DDT. Further work was recommended on the toxicity and environmental mobility of the metabolites present from the recommended composting scheme as well as controlled bench and pilot testing.

No QA/QC procedures were reported; however, quality control issues were discussed and this work was done under an EPA contract.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Nonpolar Aromatic Compounds	50-29-3	1,1,1-trichloro-2,2-bis(4-chlorophenyl)ethane (4,4-DDT)
	72-55-9	1,1-dichloro-2,2-bis (4-chlorophenyl)ethene (4,4-DDE)

NOTE: Quality assurance of data may not be appropriate for all uses.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: **Thermal Treatment - Rotary Kiln**

Media: Soil/Generic

Document Reference: Vesta Technology, Ltd. "Trial Burn Test Report, Part I - Data Summaries." Draft report of approximately 25 pp. Prepared for U.S. EPA, Region IV, March 1987.

Document Type: Contractor/Vendor Treatability Study

Contact:
Ned Jessup
U.S. EPA - Region IV
345 Courtland Street, NE
Atlanta, GA 30365
404-347-4727

Site Name: Aberdeen, NC, Superfund Site (NPL)

Location of Test: Aberdeen, NC

BACKGROUND: This treatability study summary reports on the results of a trial burn of pesticide-contaminated soil from the Aberdeen, NC Superfund site. The trial burn using the Vesta mobile rotary kiln incinerator was designed to demonstrate that this system can destroy the pesticides in a manner consistent with RCRA standards.

OPERATIONAL INFORMATION: The soil was fed to the incinerator at rates of 960 to 1023 pounds per hour. There were three trial runs completed, each for approximately 3 hours. No details are provided on the soil matrix or QA/QC accomplished. Since this Trial Burn Test Report is a summary of analytical results, additional operational information is not presented.

PERFORMANCE: The primary standards of performance were:

1. Destruction of the pesticides from the soil fed to the incinerator.
2. Destruction/removal of the designated principal organic hazardous pollutants (POHC's).
3. Particulate stack emissions.
4. Hydrogen chloride stack emissions.

Secondary standards included:

1. Other pesticide stack emissions.
2. Carbon monoxide emissions.
3. Dioxin, furan and other chlorinated organic emissions.

The soil treated had initial concentrations of P,P-DDT and alpha-BHC of greater than 131 and 29 ppm, respectively. The pesticides in the soil fed to the incinerator were effectively removed, as evidenced by the removal of the principal organic hazardous pollutants, P, P-DDT and alpha-BHC (99.993% and 99.998% removal efficiency, respectively). All other pesticides found in the contaminated soil were not detected in the treated soil. TCDD (dioxins) and TCDF (furans) were not found in the treated soil. The destruction and removal efficiency, of 99.993 percent particulate stack emissions to .02 grains/dscf and hydrogen chloride stack emissions of 99.2 percent removal were in compliance with RCRA criteria for particulate stack emissions of .08 grains/dscf and hydrogen chloride stack emissions removal of 99 percent. Carbon monoxide stack emissions and combustion efficiency were indicative of good combustion, except for one test run which experienced startup difficulties. Other stack emission parameters (flow,temperature, moisture, oxygen, and carbon dioxide) indicated successful operation. Quality control field blanks were collected and described.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Aromatic Compounds	72-55-9	1,1-Dichloro-2-2-bis (4-chlorophenyl) ethene (4,4-DDE)
	72-54-8	1,1-Dichloro-2,2-bis (4-chlorophenyl)ethane (4,4-DDD)
	50-29-3	1,1,1-Trichloro-2,2-bis (4-chlorophenyl)ethane (4,4-DDT)
W05-Halogenated Cyclic Aliphatics/Ethers/Esters/Ketones	1024-57-3	Heptachlor Epoxide
	1031-07-8	Endosulfan Sulfate
	309-00-2	Aldrin
	319-85-7	Beta-BHC
	33213-65-9	Endosulfan II
	58-89-9	Gamma-BHC
	60-57-1	Dieldrin
	72-20-8	Endrin
	7421-93-4	Endrin Aldehyde
	76-44-8	Heptachlor
	959-98-8	Endosulfan I
	319-86-8	Delta-BHC

NOTE: **Quality assurance of data may not be appropriate for all uses.**

3/89-16 **Document Number: EZUY**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Thermal Treatment - Incineration

Media:	Soil/Generic
Document Reference:	Environmental Science and Engineering, Inc. "Final Report, Phase I - Immediate Assessment, Acme Solvents Site." Technical report of approximately 40 pp. submitted to the Acme Solvents Technical Committee. November 1985.
Document Type:	Contractor/Vendor Treatability Study
Contact:	David Favero U.S. EPA - Region V 230 South Dearborn Street Chicago, IL 60604 312-386-4749
Site Name:	Acme Solvents Site (NPL)
Location of Test:	Rockford, IL

BACKGROUND: This is a site assessment and feasibility study of incineration alternatives at the ACME Solvents Site at Rockford, Illinois. The document contains laboratory results that are reported to simulate incineration conditions but no details on test methods were provided.

OPERATIONAL INFORMATION: The document summarizes the geophysical investigation, the delineation of the contaminated zones and their volumes and the sampling locations. Out of 43 samples taken at 18 locations, 20 were selected to be sent to an environmental laboratory for analysis of percent moisture (volatiles), percent ash, total chloride, total sulfur, Btu value and total PCBs. Two samples were analyzed for organic priority pollutants, pesticides and PCBs. No details on test methods were provided. Details on the soil matrix of each sample were summarized (the majority are silty soil). The ash from each of the 20 samples was analyzed for EP toxic metals. The data from these 20 samples is summarized as well as the more complete analysis results from the two samples.

This basic data was used in an analysis of feasibility, costs and relative merits of off-site and on site incineration of the contaminated site material. Specific alternatives are costed for an on site rotary kiln and an off-site rotary kiln.

PERFORMANCE: The laboratory test on the soil for EP toxicity showed the resulting ash/decontaminated soil was consistently well below EPA limits for hazardous wastes classification. Heavy metal levels in the decontaminated ash ranged from a high of 2.26 mg/l for Cr to a low of less than .009 mg/l for Se. All were well below the EP toxicity levels defined in 40 CFR 261.4 except for chromium which is about 50% of the allowed EP toxicity level of 5 mg/l. PCBs were reduced from 3600 to less than 4 µg/kg dry. There are no details provided on the laboratory incineration process, sampling protocols, QA/QC protocols or conclusions.

The economic analysis comparing onsite and off-site incineration showed onsite incineration could be accomplished at one-third the cost and with the same implementation time as the off-site incineration.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02-Dioxins/Furans/PCBs	12674-11-2	PCB-1016
	11096-82-5	PCB-1260
W05-Halogenated Cyclic Aliphatics/Ethers/Esters/Ketones	57-74-9	Chlordane
	58-89-9	Gamma-BHC(Lindane)
W08-Polynuclear Aromatics	83-32-9	Acenaphthene
	91-20-3	Naphthalene
	85-01-8	Phenanthrene
	86-73-7	Fluorene
W09-Other Polar Organic Compounds	117-81-7	Bis(2-ethyhexyl) phthalate
	85-68-7	Butylbenzylphthalate
	84-74-2	Di-n-butylphthalate
	117-84-0	Di-n-octylphthalate
	78-59-1	Isophorene
	108-95-2	Phenol
W10-Non-Volatile Metals	7440-39-3	Barium
W11-Volatile Metals	7439-92-1	Lead
	7439-97-6	Mercury
	7440-22-4	Silver
	7440-43-9	Cadmium

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-27 **Document Number: EZYN**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: **Physical/Chemical - Low Temperature Thermal Stripping**

Media: Soil/Generic

Document Reference: PEI Associates, Inc. "Low Temperature Treatment of CERCLA Soils and Debris Using the IT Laboratory Scale Thermal Desorption Furnaces." Prepared for U.S. EPA, HWERL, Cincinnati, OH. 120 pp. October 1987.

Document Type: EPA ORD Report

Contact:
Robert Thurnau
U.S. EPA, ORD
HWERL
26 W. St. Clair Street
Cincinnati, OH 45268
513-596-7692

Site Name: BDAT SARM-Manufactured Waste (Non-NPL)

Location of Test: ORD - Edison, NJ

BACKGROUND: This study report on laboratory experiments on low temperature treatment of soils using thermal desorption. The purpose of the study was to determine if thermal desorption could remove volatile and semi-volatile contaminants from a synthetically prepared soil spiked with predetermined quantities of contaminants. This study supports the U.S. EPA's program to demonstrate various technologies for treating contaminated soils for the purposes of CERCLA/SARA compliance with the proposed 1988 banning of land disposal of wastes.

OPERATIONAL INFORMATION: The laboratory testing program consisted of 15 separate bench-scale tests. The EPA synthetic soil had two levels of contaminants which are shown in the table on the next page. Thermal desorption tests were conducted at three temperatures 150°C, 350°C and 500°C for 30 minutes to determine the effect of temperature on thermal desorption efficiency. The surrogate soil or synthetic analytical reference matrix (SARM) is similar to Superfund site soils and is 30% by volume clay, 25% silt, 20% sand, 20% topsoil and 5% gravel. The SARMs were air dried to minimize moisture. Approximately 80 gms of SARM soil were used in the tests in the tray furnace. The tray furnace interior space is approximately 10 cm wide, 14 cm high and 21 cm deep. A QA/QC plan is contained in the study. Gas bags were utilized to collect off gas samples from the furnace and THC, CO, CH_4 and C_2H_5 were analyzed by GC. Soils were analyzed for the remaining SARM constituents using GC/MS.

PERFORMANCE: Thermal desorption of volatile and semi-volatile contaminants from soils at moderate temperatures can be achieved with reasonable success. At 550°C most of the volatile constituents are removed to below the one/ppm level. Acetone appeared to remain in the matrix possibly due to bound water in the soil. Semivolatile constituents are also removed to a large extent except for pentachorophenol. Anthracene and phalate are removed to levels near the detection limit. At 350°C temperature most of the volatile contaminants are removed down to the 1 ppm level except for acetone. Semivolatiles are reduced at 350°C, though not significantly. The author cautions not to place quantitative credence in the results since the precision of duplicate samples indicated that the data is only useful in a qualitative manner.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Aromatic Compounds	108-90-7	Chlorobenzene
WO3-Halogenated Phenols, Cresols, Thiols	87-86-5	Pentachlorophenol
W04-Halogenated Aliphatic Solvents	107-06-2	1,2-Dichloroethane
	127-18-4	Tetrachloroethene
W07-Heterocyclics and Simple Aromatics	100-42-5	Styrene
	100-41-4	Ethylbenzene
	1330-20-7	Xylenes
W08-Polynuclear Aromatics	120-12-7	Anthracene
W09-Other Polar Organic Compounds	67-64-1	Acetone
	117-81-7	Bis(2-ethylhexyl)phthalate
W10-Non-Volatile Metals	7440-02-0	Nickel
	7440-47-3	Chromium
	7440-50-8	Copper
W11-Volatile Metals	7440-38-2	Arsenic
	7440-43-9	Cadmium
	7439-92-1	Lead
	7440-66-6	Zinc

NOTE: **Quality assurance of data may not be appropriate for all uses.**

3/89-40 **Document Number: EZYQ**

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SARM Contaminants Utilized in Thermal Desorption Test and Their Concentrations in the Soil (ppm)

	High	Low
Volatiles		
Ethylbenzene	3200	320
Xylene	8200	820
Tetrachloroethylene	600	60
Chlorobezene	400	40
Styrene	1000	100
1,2 Dichloroethane	600	60
Acetone	6800	680
Semivolatiles		
Anthracene	6500	650
Bis (2-ethylhexyl) phtahalate	2500	250
Pentachlorophenol	1000	100
Metals		
Lead		280
Zinc		450
Cadmium		20
Arsenic		10
Copper		190
Nickel		30
Chromium		30

Note: This is a partial listing of data. Refer to the document for more information.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Biological - Aerobic

Media: Soil/Generic

Document Reference: ECOVA Corporation. "Final Report: Soil Treatment Pilot Study Brio/DOP Site." Technical Report No. 861014/1 (Ecova No.) prepared for U.S EPA Brio Site Task Force. Approximately 130 pp. June 1987.

Document Type: Contractor/Vendor Treatability Study

Contact:
Louis Barinka
U.S. EPA - Region VI
1445 Ross Avenue
12th Floor, Suite 1200
Dallas, TX 75202
212-655-6735

Site Name: Brio DOP Site (NPL)

Location of Test: Friendswood, TX

BACKGROUND: Bench and pilot-scale studies were conducted to demonstrate the feasibility of using solid-phase biodegradation for destroying portions of organic constituents present in the soil. The predominant constituents at the BRIO DOP site located in Texas were volatile compounds such as: methylene chloride, 15-17,000 ppb; 1,2-dichloroethane, 25-195,000 ppb; 1,1,2-trichloroethane, 25-195,000 ppb. Semivolatile compounds were present in lower concentrations: phenanthrene, 1,392-15,083 ppb; anthracene and fluorene, 440-563 ppb (single samples only).

OPERATIONAL INFORMATION: Aerobic microorganisms present in soil samples removed from the site ranged from 10^3 to 10^5 colony forming units per gram weight of wet soil, indicating the site contained a diverse microbial population. Bench-scale and pilot-scale tests were conducted. The pilot-scale solid phase treatment facility consisted of a lined soil treatment area with a leachate collection system, water/nutrient distribution system, emission control system, a microbiological management system, and greenhouse enclosure and support facilities. The pilot facility was operated for 94 days commencing in January of 1987. Two hundred (200) cubic yards of soil removed from the site were placed in the pilot facility, inoculated with microorganisms, nutrients were added (inorganic N&P), and the soils were tilled daily to ensure contact and aeration. Tilling also facilitated air stripping of the more volatile organics. Volatile compounds were trapped by activated carbon absorbers at the pilot facility.

PERFORMANCE: The pilot-scale treatment facility demonstrated under field conditions that a solid-phase treatment process could be used to successfully treat the organic constituents present in the site soil. The process removed the volatile organic compounds by air stripping, and destroyed semivolatile organic compounds by biodegradation. More than 99% of the volatile organic compounds were removed within the first 21 days of operation. However, the biodegradation of the semivolatile organic constituents was much slower. It was estimated that approximately 131 days would be required to reduce the phenanthrene concentrations to non-detectable levels in the treatment facility. The time required to treat affected soils and materials (volatile/ semivolatile organics) in a solid phase treatment process might be unacceptably long if rapid remediation is required.

No actual tests were conducted on a full scale facility. However, the authors discuss the feasibility of full scale tests and postulate that aqueous phase biodegradation could enhance the rate of removal of the organic components by improving the contact between microorganisms, nutrients, and oxygen. No treatment cost data was provided. Numerous references to the biodegradation of specific organic compounds are contained in this document. EPA analytical methods were utilized to analyze for volatile organics. A QA/QC plan is contained in the document along with a statistical analysis of the data.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Aromatic Compounds	108-90-7	Chlorobenzene
W04-Halogenated Aliphatic Solvents	79-34-5	1,1,2,2-Tetrachloroethane
	79-00-5	1,1,2-Trichloroethane
	75-09-2	Methylene Chloride
	75-34-3	1,1-Dichloroethane
W07-Heterocyclics and Simple Aromatics	100-41-4	Ethylbenzene
	100-42-5	Styrene
	71-43-2	Benzene
	108-88-3	Toluene
	1330-20-7	Xylenes
W08-Polynuclear Aromatics	91-20-3	Naphthalene
	85-01-8	Phenanthrene
	91-57-6	2-Methylnaphthalene
W09-Other Polar Organic Compounds	67-64-1	Acetone
	78-93-3	2-Butanone

NOTE: Quality assurance of data may not be appropriate for all uses.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Thermal Destruction - Infrared

Media:	Soil/Clayey
Document Reference:	Shirco Infrared Systems. "Final Report, Onsite Incineration Testing at Brio Site, Friendswood, Texas" Final Technical Report No. 8467-87-1 prepared for the U.S. EPA Brio Task Force. Approximately 750 pp. February 1987.
Document Type:	Contractor/Vendor Treatability Study
Contact:	U.S. EPA - Region I John F. Kennedy Federal Building, Room 2203 Boston, MA 02203 617-565-3715
Site Name:	Brio Refinery Superfund Site (NPL)
Location of Test:	Friendswood, TX

BACKGROUND: Shirco Infrared Systems, operated a pilot-scale infrared unit on-site at the Brio Refinery Site in Texas. Eight tests were run over a four day period with various soil compositions, including clay-like soils from four pits.

OPERATIONAL INFORMATION: The objectives of these thermal pilot treatment tests on excavated pit material were as follows:

1. To determine the incinerator ash chemical composition.
2. To demonstrate that the incinerator feed system can reliably provide a continuous, blended feed to the incinerator and deposit this feed material in a uniform manner on the incinerator belt.
3. To demonstrate that the incinerator can meet the RCRA required >99.99% destruction efficiency for Principal Organic Hazardous Constituents (POHCs).
4. To provide design information and economic data required to evaluate the feasibility of incinerating certain Brio Site pit wastes.

The feed analyses targeted approximately 120 priority pollutants. However, only 18 were usually found above the detection limits. Each sample tested was about 50 pounds and was spiked with carbon tetrachloride as the principal organic hazardous constituent. The soil was mechanically worked and screened to break up clay lumps. The destruction of the spiked contaminant was used to measure the success of the testing. Other analyses performed included analysis of the scrubber inlet and outlet, stack flow, and ash. The ash analyses included a mass and volume reduction analysis.

PERFORMANCE: Removal efficiency under all test conditions with 12 or 18 minute primary chamber residence time at 1600°F was greater than 99.9997%. The cost of treatment with their largest mobile unit, which will process 67,000 tons per year, was estimated at $119 per ton. This does not include costs of feed excavation, feed preparation, interest and taxes. The document details each aspect of the tests, which lends much credibility to its data. QA/QC and sampling protocol are given along with details of the testing procedures, test equipment, materials, and results. Sections are devoted entirely to results, safety procedures, an economic analysis and conclusions and recommendations.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Aromatic Compounds	108-90-7	Chlorobenzene
W04-Halogenated Aliphatic Solvents	71-55-6	1,1,1-Trichloroethane
	79-34-5	1,1,2-Tetrachloroethane
	75-35-4	1,1-Dichloroethene
	107-06-2	1,2-Dichloroethane
	56-23-5	Carbon Tetrachloride
	67-66-3	Chloroform
	127-18-4	Tetrachloroethene
	79-01-6	Trichloroethene
	75-01-4	Vinyl Chloride
W07-Heterocyclics and Simple Aromatics	71-43-2	Benzene
	100-41-4	Ethylbenzene
	100-42-5	Styrene
W08-Polynuclear Aromatics	91-20-3	Naphthalene
	85-01-8	Phenanthrene
W09-Other Polar Organic Compounds	67-64-1	Acetone
	75-15-0	Carbon Disulfide

NOTE: Quality assurance of data may not be appropriate for all uses.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: **Thermal Treatment - Infrared**

Media: Sludge

Document Reference: Shirco Infrared Systems Portable Test Unit. "Final Report - Demonstration Test On-Site PCB Destruction, Shirco Infrared Portable Unit at Florida Steel Indiantown Mill Site, Indiantown, Florida." Technical report of approximately 180 pp. prepared for internal use by Shirco. September 1986.

Document Type: Contractor/Vendor Treatability Study

Contact:
John Kroske
U.S. EPA - Region IV
345 Courtland Street, NE
Atlanta, GA 30336

Site Name: Florida Steel Indiantown Mill Site, FL (NPL)

Location of Test: Shirco, Joplin, MO

BACKGROUND: This document reports on the results of a Florida Steel Corporation study to develop and evaluate cleanup alternatives for onsite treatment of PCB contaminated soils. The results of this study aided in the selection of an approach to remediate the site. Demonstration tests on incinerating PCBs were conducted at the site May 13-15, 1986 by Shirco Infrared Systems of Dallas, Texas. The purpose of the tests was to demonstrate the capability of the Shirco System to meet the requirements of 40 CFR Part 761 while detoxifying the soil.

OPERATIONAL INFORMATION: Soils at the Florida Steel Corporation Site were contaminated with PCBs in the concentration range of 76 to 2970 ppm. The report does not provide any specific details on the amount of site soil contaminated, or the types of soils undergoing treatment. The Shirco Portable Pilot Test Unit used in the tests is a three stage system; infrared furnace, propane fired afterburner, and scrubber. The waste materials are weighed in batches and placed on a conveyer belt which feeds the material to the furnace. The soil is heated in the infrared furnace for a minimum residence time of 15 to 25 minutes, soil/ash is discharged and the exhaust gas passes into the propane-fired afterburner. The afterburner operates at temperatures from 1900 to 2200°F. Minimum afterburner residence time is two seconds. The afterburner exhaust gases are analyzed for various contaminants associated with PCB degradation products, as required by 40 CFR 761. Additionally the afterburner exhaust is continuously monitored for O_2, CO_2, CO and NO_x levels. A QA/QC plan is contained in this report.

PERFORMANCE: Six tests were conducted to determine the Destruction Removal Efficiencies (DRE) for PCBs. In four of six tests the DRE of 99.9999% was achieved. The remaining two tests achieved a slightly lower DRE than required; 99.999 and 99.998. The author believes this was due in one instance to low concentrations of PCB in the waste feed stream, and in the second instance, to a low level of excess O_2. This low excess 0_2 level indicates that for the Shirco unit the minimum permissible 0_2 level in the afterburner exhaust should be increased from that level used in the program. The tests that met the DRE had afterburner O_2 from 9 to 13%. Test five, the low PCB DRE test, had an O_2 concentration of 6.9%. Concentrations of particulates in the flue gas were well within the limit of 0.08 gr/scf. HCl emissions for each test were less than 4 lbs/hr. Also, scrubber effluent and flue gases were analyzed for dioxins and furon in one test run. None were found within detection limits.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02- Dioxins/Furans/PCBs	APCB	Monochlorobiphenyl
	BPCB	Dichlorobiphenyl
	CPCB	Trichlorobiphenyl
	DPCB	Tetrachlorobiphenyl
	EPCB	Pentachlorobiphenyl
	FPCB	Hexachlorobiphenyl

NOTE: **Quality assurance of data may not be appropriate for all uses.**

3/89-23 **Document Number: EZZC**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Immobilization - Flyash Solidification

Media: Sludge/Metal Finishing

Document Reference: VeriTec Corp. Case Study, Hazardous Waste Management Utilizing Lime. Paper presented at the Annual Meeting of the National Lime Association, Phoenix, Arizona. 13 pp. April 9, 1987.

Document Type: Conference Paper

Contact:
Andre DuPont
National Lime Association
3601 North Fairfax Drive
Arlington, VA 22201
703-243-LIME

Site Name: VeriTec Corp. (Non-NPL)

Location of Test: Knoxville, TN

BACKGROUND: This report presents the results of treating a plating sludge having high levels of Cu, Ni and Cr with a lime fly ash additive. The pozzolonic reaction solidified the sludge. The results of various leaching tests are presented and discussed. An economic analysis suggests that the mixture used was more cost effective than other types of solidifying agents and processes. Various additive sludge ratios are recommended and a conceptual system design along with costs is presented.

OPERATIONAL INFORMATION: The sludge that was investigated was a Cu-Ni-Cr hydroxide sludge from alkaline pH precipitation of a plating-rinse wastewater. The untreated sludge contains 35 g/kg of Cu, 65g/kg Ni and 72 g/kg of Cr. Sludge density is 1.133 g/cc. Lab tests revealed that solidification was feasible and that the solidified samples displayed considerable unconfined compressive strength. The structural strength was reported to be between 100-125 psi. Lab tests were followed with field tests to determine the effect of leaching on the solid samples. At 21 days treated samples were subject to the EPA-RCRA EP toxicity procedures, deionized water leaching procedures, and the Multiple Extraction Procedure (MEP) leaching test. Detailed explanation of the leaching procedures are given along with methods of analysis used to determine heavy metal concentrations. No QA/QC information is contained in the report.

PERFORMANCE: Laboratory simulation studies revealed that the fixation process could reduce the EP toxicity. EP toxicity tests for Cr, Ni and Cu with initial concentrations of 73.0, 65.6 and 22.0 mg/l, respectively, were reduced by treatment to 2.9, 1.0 and 1.0 mg/l, respectively. Field tests reveal that levels of Ni, Cr and Cu can all be reduced by the fixation process. The following tables show results from the various leaching tests. Cyanide (CN) is not used in the plant, however, CN was found at 0.13 and 0.05 ppm in the raw sludge leachate samples. CN was <0.01 in all treated sludge samples showing this fixation process also retards low level leaching of cyanides. Total chromium was reduced from 22 to .02 - .05 ppm in one set of samples and from 3.5 ppm to 0.4 - 0.1 ppm in another set of samples. Nickel was reduced from 87 to 0.01 ppm with treatment. The authors state that they believe the wastes no longer violate hazardous waste criteria and recommend that the treated wastes be delisted.

An economic analysis of the costs associated with fixing one ton of sludge using a 1:1 mass ratio of fixing agent and sludge was conducted. Pozzolonic process is the cheapest of those evaluated. Cement costs $70 per ton whereas pozzolonic costs as low as $12.50 per ton depending on the type of fly ash used (bulk or bagged). Total disposal costs increase as the mass ratio of fixing agent to dry weight sludge increases. The authors provide a conceptual design of a process along with estimated costs to construct a one ton per day system. Total system capital/construction costs are estimated to be $65,000.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W10-Nonvolatile Metals	7440-47-3	Chromium
	7440-02-0	Nickel
W11-Volatile Metals	7440-43-9	Cadmium
W12-Other Inorganics	57-12-5	Cyanide

Leaching Studies of Raw and LFA Fixated (2:1) Cylinders

	Untreated EPA-RCRA	Treated EPA-RCRA	Untreated D.I. H_20	Treated D.I. H_20
Cr	73.0*	2.9	0.63	<0.01
Ni	65.6	1.0	0.61	0.04
Cu	22.0	1.0	0.24	0.07

*All values in mg/l of leachate.

NOTE: Quality assurance of data may not be appropriate for all uses.

EPA-RCRA Leach Testing of LFA Treated and Untreated Sludges

Metals	Untreated	Treated
Arsenic	<0.001*	<0.001
Barium	0.23	0.09
Cadmium	<0.001	<0.001
Chromium	7.4	0.81
Lead	<0.01	<0.01
Mercury	<0.001	<0.001
Selenium	<0.001	0.002
Nickel	3.9	4.8
Copper	2.4	0.02

*All values in mg/l of leachate.

Plating Sludge Leachate Levels (mg/liter)

	CN[1]	Cd	Ni	Cr
Raw Unreacted	0.13	0.001	87.0	22.0
Fixated #1	<0.01	0.004	<0.01	0.03
	<0.01	<0.001	<0.01	0.02
Fixated #2	<0.01	<0.001	<0.01	0.05
	<0.01	<0.001	<0.01	0.05
Raw Unreacted	0.05	<0.001	76.0	3.5
Fixated #3	<0.01	<0.001	0.15	0.10
	<0.01	<0.001	<0.01	0.04
Fixated #4	<0.01	<0.001	<0.01	0.07
	<0.01	<0.001	<0.01	0.07

*All values in mg/l of leachate.

[1] CN - Cyanide

Note: This is a partial listing of data. Refer to the document for more information.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Physical/Chemical - Dechlorination

Media: Soil/Generic

Document Reference: Research Triangle Institute. "PCB Sediment Decontamination Process-Selection for Test and Evaluation," and slide presentation on "Effective Treatment Technologies for the Chemical Destruction of PCB." Approximately 200 pp. Prepared for U.S. EPA, HWERL. May 1987.

Document Type: EPA ORD Report

Contact:
Dr. Clark Allen
Research Triangle Institute
P.O. Box 12194
Research Triangle Park, NC 27709
919-541-5826

Site Name: Guam (Non-NPL)

Location of Test: Research Triangle Park, NC

BACKGROUND: This document is a report describing the assessment of seven alternative treatment processes that show potential for decontaminating polychlorinated biphenyl (PCB)-contaminated sediments. The processes are KPEG, MODAR Supercritical Water Oxidation, Bio-Clean, Ultrasonics/UV, CFS Extraction, B.E.S.T., and Low Energy Extraction. Each process was evaluated using five criteria: the probability of cleaning sediments to 2 ppm or less; the availability of a test system; the test and evaluation effort required; the time required for future availability of a commercial treatment process; and the probable cost of treatment using the process. The evaluation of the criteria for each process was carried out by engineering analysis of available data and site visits to developers' facilities. This report deals with the KPEG process for the destruction of PCBs.

OPERATIONAL INFORMATION: The KPEG process was demonstrated in the treatment of contaminated soil on Guam by way of the Galson Terraclean-Cl process. This destroys PCBs by nucleophilic substitution. Potassium hydroxide is reacted with polyethylene glycol (PEG) to form an alkoxide. The alkoxide reacts to produce an ether and potassium chloride.

Addition of an RO-group enhances the solubility of the molecule and makes it less toxic. The reaction may continue until several chlorine atoms are removed from the PCB molecule. The reagent consists of a mixture of PEG, potassium hydroxide, and dimethyl sulfoxide (DMSO).

Contaminated soil or sediment is fed to the reactor from 55-gallon drums. An equal volume of reagent is added to the soil in the reactor. The reagent is blended with the soil using a stainless steel bladed mixer.

During operation of the system, contaminated reagent is mixed with make-up reagent in the reagent storage tank and recirculated into the reaction vessel containing contaminated soil. The reaction vessel is heated (150°C) and the soil and reagent are kept mixed until the reaction is complete. Volatilized material from the bulk storage tank and the reaction vessel are vented through a charcoal adsorption unit. Water vapor is condensed and used as wash water. The reagent is decanted, weighed, and stored for reuse. The soil is washed twice with water to remove excess reagent, and the wash water is held for analysis and possible treatment with activated carbon.

The treated soil is held for analysis. If PCB concentration is greater than 2 ppm, the soil is retreated. QA/QC procedures are not discussed.

PERFORMANCE: It was found that all of the processes assessed have merit. In selecting the most promising ones, a ranking system was used based on the five criteria mentioned in the background section. The processes were ranked comparatively as to the desirability for thorough testing and evaluation. The KPEG process was ranked 5th with a score of 0.58, within a range of scores from 0.49 to 0.62. Laboratory-scale KPEG treatments were applied and there was a reduction of PCB levels to 17.5 ppm by treating the soil 5 hours at 115° to 120°C. Residual PCBs were qualitatively identified as penta- and hexa-chloro biphenyl. These congeners had been reduced 75 percent and 60 percent, respectively, by the treatment. Galson reported reduction from 1800 to 2.3 ppm by treatment at 150°C for 2 hours.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02- Dioxins/Furans/PCBs	1336-36-3 11096-82-5	Total PCBs PCB-1260

NOTE: Quality assurance of data may not be appropriate for all uses.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Thermal Treatment - Critical Water Oxidation

Media:	Soil/Generic
Document Reference:	Research Triangle Institute. "PCB Sediment Decontamination Process-Selection for Test and Evaluation," and slide presentation on "Effective Treatment Technologies for the Chemical Destruction of PCB." Approximately 200 pp. Prepared for U.S. EPA, HWERL. May 1987.
Document Type:	EPA ORD Report
Contact:	Dr. Clark Allen Research Triangle Institute P.O. Box 12194 Research Triangle Park, NC 27709 919-541-5826
Site Name:	Guam (Non-NPL)
Location of Test:	Research Triangle Park, NC

BACKGROUND: This document is a report describing the assessment of seven alternative treatment processes that show potential for decontaminating polychlorinated biphenyl (PCB)-contaminated sediments. The processes are KPEG, MODAR Supercritical Water Oxidation, Bio-Clean, Ultrasonics/UV, CFS Extraction, B.E.S.T., and Low Energy Extraction. Each process was evaluated using five criteria: the probability of cleaning sediments to 2 ppm or less; the availability of a test system; the test and evaluation effort required; the time required for future availability of a commercial treatment process; and the probable cost of treatment using the process. The evaluation of the criteria for each process was carried out by engineering analysis of available data and site visits to developers' facilities. This report deals with the evaluation of a critical water oxidation process to destroy PCBs.

OPERATIONAL INFORMATION: The MODAR Supercritical Water Oxidation process utilizes water above critical conditions (374°C and 22.1 MPa) to increase the solubility of organic materials and oxygen to effect a rapid oxidation, destroying organic contaminants. The PCBs are found in a slurry or sludge type material. The report attempts to evaluate systems available from C.F. System and Enseco. However, the source of the bench-scale study is not given, neither are sampling procedures, QA/QC procedures, or conclusions.

PERFORMANCE: It was found that all of the processes assessed have merit. In selecting the most promising ones, a ranking system was used based on the five criteria mentioned in the background section. The processes were ranked comparatively as to the desirability for thorough testing and evaluation. The MODAR supercritical water system was ranked 6th with a score of 0.57, within scores which ranged from 0.49 to 0.62. The destruction efficiency for PCB is given in the bottom table.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02-Dioxins/Furans/PCBs	1336-36-3	Total PCBs

Waste Destruction Efficiency MODAR/CECOS Demonstration Organic Waste Test

Contam-inant	Feed rate (g/min)	Liquid effluent rate (g/min)	Gaseous effluent rate (g/min)	Destruction efficiency %
PCB	9.1×10^{-2}	$< 3.1 \times 10^{-7}$	$< 4.4 \times 10^{-6}$	>99.9995

Note: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Immobilization - Stabilization

Media: Soil/Generic

Document Reference: Lopat Enterprises, Inc. "Representative Selection of Laboratory Experiments and Reports of Full-Scale Commercial Use Which Demonstrate the Effectiveness of K-20 Lead-in Soil Control System in Physical/ Chemical Solidification, Fixation, Encapsulation & Stabilization of Certain Soil, Ash, Debris and Similar Wastes." Technical data report. Approximately 60 pp. Assembled for CDM. August 1987.

Document Type: Contractor/Vendor Treatability Study

Contact:
Lou Parent
Lopat Enterprises, Inc.
1750 Bloomsbury Avenue
Wanamassa, NJ 07712
201-922-6600

Site Name: Confidential

Location of Test: Lopat Enterprises, Inc., Wanamassa, NJ

BACKGROUND: The report consists of brief summaries of seven bench-scale tests conducted by Lopat Enterprises for their clients. Lopat Enterprises report that their technique will stabilize solids contaminated with inorganic volatile and non-volatile metals (Cd, Zn, Hg,Pb, Cr, Ni, Cu), non-metallic toxic elements (As), and certain organics (PCBs).

OPERATIONAL INFORMATION: Lopat Enterprises uses a proprietary technology called K-20™ Lead-in-Soil Control System (K-20/LSC) for the physical/chemical fixation, solidification, encapsulation, and stabilization of contaminated soil and soil-like matrices. In the K-20/LSC system, two liquid components are blended and diluted prior to application to dry waste. Dry fixative materials are then added to the wetted waste material, and the dry waste are mixed with the K-20/LSC system components and allowed to cure for a day or more. The formulation of these components is site specific and proprietary. The volume of wastes treated varied with each project and was not reported.

PERFORMANCE: Lopat Enterprises reports that the K-20/LSC system is capable of reducing leachate concentrations by 90%. The document presents EP Toxicity test results before and after fixation of electric arc furnace dust, auto shredder residue, paint manufacturing sludge, blasting sand, incinerator bottom ash, blast furnace slag, and oil-soaked soil. Data are presented for Pb, Cd, Zn, As, Ba, and Cr. Initial concentrations of lead ranged from 9.8 ppm to 6200 ppm, although they are generally between 10 and 500 ppm. The initial concentrations and the percent reductions in metal concentrations in the leachate are summarized in the table on the next page. The percent reductions were highest for lead and lowest for chromium and barium. Costs reported were in the range of $15 to $20 per ton. QA/QC was not reported.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W10-Nonvolatile Metals	7440-47-3	Chromium
W11-Volatile Metals	7439-92-1	Lead

Note: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

Summary of Performance Data
The following data is provided by Lopat Enterprises for their K-20/LSC stabilization treatment. The upper number is the concentration in the leachate prior to treatment, as determined by the EP Toxicity test. (Concentrations in the auto shredder residue were measured by the California Administrative Manual Waste Extraction Test.) The lower number is the percent reduction in leachate concentration following treatment.

Waste	Pb	Cd	Zn	As	Ba	Cr
Electric arc furnace dust	580 ppm 97-99%	0.023 ppm >80%				
Auto shredder residue	150-250 ppm >80%	2-6.7 ppm >65- >85%	900-1600 >85%			
Incinerator bottom ash	70.5 ppm >99%	0.048 ppm 67%- >90%		0.17 ppm 59- >94%	35 ppm >1-95%	0.06 ppm 83%
Blasting sand	6200 ppm 99%					
Paint manufacturing sludge	9.8 ppm 63- >95%					1 ppm 7-44%
Blast furnace slag	500 ppm 99%					
Oil soaked soil	16.3 ppm 99%					

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Thermal Treatment - Circulating Bed Combustion

Media: Soil/Generic

Document Reference: Alliance Technologies Corp. "Technical Resource Document: Treatment Technologies for Dioxin/ Containing Wastes." Technical Report EPA/600/2-86/096. 244 pp. October 1986.

Document Type: EPA ORD Report

Contact:
Harold Freeman
U.S. EPA, ORD
HWERL-Thermal Destruction Branch
26 W. St. Clair Street
Cincinnati, OH 45268
513-569-7529

Site Name: Denny Farm Site, MO (Non-NPL)

Location of Test: Denny Farm, MO

BACKGROUND: GA Technologies conducted the circulating bed combustor (CBC) pilot scale tests using PCB-contaminated soils. This treatability study compiles available information on those technologies for dioxin containing solids, liquids and sludges, many of which are in early stages of development. Discussion of the CBC pilot test is contained in this abstract. Other technologies in this document are discussed in Document Numbers FCFR-4 and FCFR-6. Technologies evaluated were those that destroy or change the form of dioxin to render it less toxic. Those technologies not tested on dioxin-containing wastes had been tested on PCB-containing wastes. The report divides the technologies into thermal and non-thermal groups for discussion. It was noted that incineration was the only sufficiently demonstrated technology for treatment of dioxin containing wastes (51 FR 1733) and RCRA Performance Standards for Thermal Treatment require 99.9999 percent destruction removal efficiency (DRE) of the principal organic hazardous constituent (POHC). Factors which affect the selection/use of a particular technology are discussed. Technical performance for treating a specific waste type and costs are both considered in this discussion. A summary of dioxin treatment processes, their performance/destruction achieved, and estimated costs are provided in the table on the next page. QA/QC is not discussed.

OPERATIONAL INFORMATION: GA Technologies conducted trial burns on PCB-contaminated soil with 9800 to 12,000 ppm of PCB. Auxiliary fuel was used to maintain the bed temperature at 1600° to 1800°F. A soil feed rate of 325 to 410 pounds per hour was used.

PERFORMANCE: A destruction efficiency exceeding six nines (99.9999 percent) was achieved. Costs of fluidized bed treatment are dependent on fuel requirements, scale and site conditions. Cost estimates of from $27/ton to $150/ton are provided for various assumptions.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02-Dioxins/Furans/PCBs	1336-36-3	Total PCBs

Note: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

Summary of Dioxin Treatment Processes

Process Name	Performance/Destruction Achieved	Cost
Stationary Rotary Kiln Incineration	Greater than 99.999 DRE demonstrated on dioxin at combustion research facility	\$0.25 - \$0.70/lb for PCB solids
Mobile Rotary Kiln Incineration	Greater than 99.9999 DRE for dioxin by EPA unit; process residuals delisted	NA
Liquid Injection Incineration	Ocean incinerators only demonstrated 99.9 on dioxin-containing herbicide orange	\$200 - \$500/ton
Fluidized-bed Incineration	Greater than 99.9999 DRE demonstrated on PCBs	\$60 - \$320/ton
Infrared Incinerator (Shirco)	Greater than 99.9999 DRE on TCDD-contaminated soil	\$200 - \$1,200 per ton
High Temperature Fluid Wall (Huber AER)	Greater than 99.999 DRE on TCDD-contaminated soil	\$300 - \$600/ton
Molten Salt (Rockwell Unit)	Up to eleven nines DRE on hexachlorobenzene	NA
Supercritical Water Oxidation	99.9999 DRE on dioxin-containing waste reported by developer	\$0.32 - \$2.00/gallon
Plasma Arc Pyrolysis	Greater than 99.9999 destruction of PCBs and CCl_4	\$300 - \$1,400/ton
In-Situ Vitrification	Greater than 99.9% destruction on PCB-contaminated soil	\$120 - \$250/M^3
Solvent Extraction	Still bottom extraction: 340 ppm TCDD reduced to 0.2 ppm; 60-90% removal from soils.	NA
Stabilization/ Fixation	Tests using cement decreased leaching of TCDD	NA
UV Photolysis	Greater than 98.7% reduction of TCDD	\$250 - \$1,200/ton
Chemical Dechlorination APEG processes	Reduction of 2,000 ppb TCDD to below 1 ppb for slurry (batch process)	\$296/ton for in situ, \$91/ton for slurry
Biological in situ addition of microbes	50-60% metabolism of 2,3,7,8-TCDD using white rot fungus	NA
Degradation using Ruthemium Tetroxide	Reduction of 70 ppb TCDD to below 10 ppb in 1 hr	NA
Degradation using Chloroiodides	Up to 92% degradation on solution of TCDD in benzene	NA

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Thermal Treatment - Pyrolysis

Media:	Soil/Generic
Document Reference:	Alliance Technologies Corp. "Technical Resource Document: Treatment Technologies for Dioxin-Containing Wastes." Technical Report EPA/600/2-86/096. 244 pp. October 1986.
Document Type:	EPA ORD Report
Contact:	Harold Freeman U.S. EPA, ORD HWERL-Thermal Destruction Branch 26 W. St. Clair Street Cincinnati, OH 45268 513-569-7529
Site Name:	Times Beach, MO (NPL)
Location of Test:	Times Beach, MO

BACKGROUND: This report focuses on the pilot scale Advanced Electric Reactor (AER). This treatability study compiles available information on those technologies for dioxin containing solids, liquids and sludges, many of which are in early stages of development. A discussion of the AER pilot test is contained in this abstract. Other technologies in this document are discussed in Document Numbers FCFR-3 and FCFR-6. Technologies evaluated were those that destroy or change the form of dioxin to render it less toxic. Those technologies not tested on dioxin-containing wastes had been tested on PCB-containing wastes. The report divides the technologies into thermal and non-thermal groups for discussion. It was noted that incineration was the only sufficiently demonstrated technology for treatment of dioxin containing wastes (51 FR 1733) and RCRA Performance Standards for Thermal Treatment require 99.9999 percent destruction removal efficiency (DRE) of the principal organic hazardous constituent (POHC). Factors which affect the selection/use of a particular technology are discussed. Technical performance for treating a specific waste type and costs are both considered in this discussion. A summary of dioxin treatment processes, their performance/destruction achieved, and estimated costs are provided in the table on the next page. QA/QC is not discussed.

OPERATIONAL INFORMATION: The AER, owned and operated by J.M. Huber Corporation, was used to treat 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). It was also used in other tests including tests at Gulfport, Mississippi, but these tests reported only removal efficiencies. Only two data points are present from the Times Beach trials, one from the treated soil and one from the baghouse catch.

The AER was operated at 3500°F-4000°F. Heating was accomplished using electrically heated carbon electrodes. A nitrogen purge gas provided the reaction atmosphere. Since oxygen was not present, it was run in a pyrolytic manner.

PERFORMANCE: High DREs could not be demonstrated due to the low amount of contamination (79 ppb in the influent soil). One limitation of the AER is that it cannot handle two-phase materials such as sludge. Soils should be dried and sized (smaller than 10 mesh) before being fed into the reactor. Another limitation is that other types of incineration processes are more cost effective for high BTU content material. Since no supplementary fuels are required, this process is better suited for low BTU material. A cost estimate guideline is included. Recently the U.S. EPA and the Texas Water Commission jointly issued J.M. Huber Corporation a RCRA permit which authorizes the incineration of any non-nuclear RCRA hazardous waste in the AER.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02-Dioxins/Furans/PCBs	1746-01-6	2,3,7,8-Tetrachloro-dibenzo-p-dioxin
	1336-36-3	Total PCBs

Note: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

Summary of Dioxin Treatment Processes

Process Name	Performance/Destruction Achieved	Cost
Stationary Rotary Kiln Incineration	Greater than 99.999 DRE demonstrated on dioxin at combustion research facility	\$0.25 - \$0.70/lb for PCB solids
Mobile Rotary Kiln Incineration	Greater than 99.9999 DRE for dioxin by EPA unit; process residuals delisted	NA
Liquid Injection Incineration	Ocean incinerators only demonstrated 99.9 on dioxin-containing herbicide orange	\$200 - \$500/ton
Fluidized-bed Incineration	Greater than 99.9999 DRE demonstrated on PCBs	\$60 - \$320/ton
Infrared Incinerator (Shirco)	Greater than 99.9999 DRE on TCDD-contaminated soil	\$200 - \$1,200 per ton
High Temperature Fluid Wall (Huber AER)	Greater than 99.999 DRE on TCDD-contaminated soil	\$300 - \$600/ton
Molten Salt (Rockwell Unit)	Up to eleven nines DRE on hexachlorobenzene	NA
Supercritical Water Oxidation	99.9999 DRE on dioxin-containing waste reported by developer	\$0.32 - \$2.00/gallon
Plasma Arc Pyrolysis	Greater than 99.9999 destruction of PCBs and CCl_4	\$300 - \$1,400/ton
In-Situ Vitrification	Greater than 99.9% destruction on PCB-contaminated soil	\$120 - \$250/M^3
Solvent Extraction	Still bottom extraction: 340 ppm TCDD reduced to 0.2 ppm; 60-90% removal from soils.	NA
Stabilization/ Fixation	Tests using cement decreased leaching of TCDD	NA
UV Photolysis	Greater than 98.7% reduction of TCDD	\$250 - \$1,200/ton
Chemical Dechlorination APEG processes	Reduction of 2,000 ppb TCDD to below 1 ppb for slurry (batch process)	\$296/ton for in situ, \$91/ton for slurry
Biological in situ addition of microbes	50-60% metabolism of 2,3,7,8-TCDD using white rot fungus	NA
Degradation using Ruthemium Tetroxide	Reduction of 70 ppb TCDD to below 10 ppb in 1 hr	NA
Degradation using Chloroiodides	Up to 92% degradation on solution of TCDD in benzene	NA

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: **Physical/Chemical - Dechlorination**

Media: Soil/Generic

Document Reference: Alliance Technologies Corp. "Technical Resource Document: Treatment Technologies for Dioxin- Containing Wastes." Technical Report EPA/600/2-86/096. 244 pp. October 1986.

Document Type: EPA ORD Report

Contact:
Harold Freeman
U.S. EPA, ORD
HWERL-Thermal Destruction Branch
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Cincinnati, OH 45268
513-569-7529

Site Name: Denny Farm Site, MO (Non-NPL)

Location of Test: Denny Farm, MO

BACKGROUND: This document summarizes several case studies on the applications of the Alkali Polyethylene Glycolate (APEG) treatment process applied to dioxin-contaminated soil. This treatability study compiles available information on those technologies for dioxin containing solids, liquids and sludges, many of which are in early stages of development. A discussion of the APEG technology is contained in this abstract. Other technologies are discussed in Document Numbers FCFR-3 and FCFR-4. Technologies evaluated were those that destroy or change the form of dioxin to render it less toxic. Those technologies not tested on dioxin-containing wastes had been tested on PCB-containing wastes. The report divides the technologies into thermal and non-thermal groups for discussion. It was noted that incineration was the only sufficiently demonstrated technology for treatment of dioxin-containing wastes (51 FR 1733) and RCRA Performance Standards for Thermal Treatment require 99.9999 percent destruction removal efficiency (DRE) of the principal organic hazardous constituent (POHC). Factors which affect the selection/use of a particular technology are discussed. Technical performance for treating a specific waste type and costs are both considered in this discussion. A summary of dioxin treatment processes, their performance/destruction achieved, and estimated costs are provided in the table on the next page. QA/QC is not discussed.

OPERATIONAL INFORMATION: This document summarized several case studies on the applications of the Alkali Polyethylene Glycolate (APEG) treatment process applied to dioxin-contaminated soil. All data are either bench or pilot scale. Two different molecular weight APEG reagents were used. Three tests were K-400 (potassium-based reagent and polyethylene glycol of average molecular weight of 400) and two tests were K-120. It is unclear whether the waste matrix was a solvent, soil, or contaminated debris. All analyses reported were total waste analyses.

PERFORMANCE: The document concludes that this technology has a potential for treating soil contaminated with dioxins. Efficiencies improve with increased temperature. Costs for the slurry process is estimated at $91/ton and for the in situ process of $296/ton.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02- Dioxins/Furans/PCBs	1336-36-3	Total PCBs
	1746-01-6	2,3,7,8-Tetrachloro-dibenzo-p-dioxin

Note: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

Summary of Dioxin Treatment Processes

Process Name	Performance/Destruction Achieved	Cost
Stationary Rotary Kiln Incineration	Greater than 99.999 DRE demonstrated on dioxin at combustion research facility	$0.25 - $0.70/lb for PCB solids
Mobile Rotary Kiln Incineration	Greater than 99.9999 DRE for dioxin by EPA unit; process residuals delisted	NA
Liquid Injection Incineration	Ocean incinerators only demonstrated 99.9 on dioxin-containing herbicide orange	$200 - $500/ton
Fluidized-bed Incineration	Greater than 99.9999 DRE demonstrated on PCBs	$60 - $320/ton
Infrared Incinerator (Shirco)	Greater than 99.9999 DRE on TCDD-contaminated soil	$200 - $1,200 per ton
High Temperature Fluid Wall (Huber AER)	Greater than 99.999 DRE on TCDD-contaminated soil	$300 - $600/ton
Molten Salt (Rockwell Unit)	Up to eleven nines DRE on hexachlorobenzene	NA
Supercritical Water Oxidation	99.9999 DRE on dioxin-containing waste reported by developer	$0.32 - $2.00/gallon
Plasma Arc Pyrolysis	Greater than 99.9999 destruction of PCBs and CCl_4	$300 - $1,400/ton
In-Situ Vitrification	Greater than 99.9% destruction on PCB-contaminated soil	$120 - $250/M^3
Solvent Extraction	Still bottom extraction: 340 ppm TCDD reduced to 0.2 ppm; 60-90% removal from soils.	NA
Stabilization/ Fixation	Tests using cement decreased leaching of TCDD	NA
UV Photolysis	Greater than 98.7% reduction of TCDD	$250 - $1,200/ton
Chemical Dechlorination APEG processes	Reduction of 2,000 ppb TCDD to below 1 ppb for slurry (batch process)	$296/ton for in situ, $91/ton for slurry
Biological in situ addition of microbes	50-60% metabolism of 2,3,7,8-TCDD using white rot fungus	NA
Degradation using Ruthemium Tetroxide	Reduction of 70 ppb TCDD to below 10 ppb in 1 hr	NA
Degradation using Chloroiodides	Up to 92% degradation on solution of TCDD in benzene	NA

NOTE: **Quality assurance of data may not be appropriate for all uses.**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Physical/Chemical - Dechlorination

Media: Sludge/Generic

Document Reference: Galson Research Corp. "Bengart and Memel (Bench-Scale), Gulfport (Bench and Pilot-scale), Montana Pole (Bench-scale), and Western Processing (Bench-scale) Treatability Studies." 10 pp. July 1987.

Document Type: Contractor/Vendor Treatability Study

Contact:
Timothy Geraets
Galson Research Corp.
6601 Kirkville Road
E. Syracuse, NY 13057
315-463-5160

Site Name: NCBC Gulfport, MS (Non-NPL)

Location of Test: Galson Technical Services, Syracuse, NY

BACKGROUND: This document presents summary data on the results of various treatability studies (bench and pilot scale), conducted at three different sites where soils were contaminated with dioxins or PCBs. The synopsis is meant to show rough performance levels under a variety of different conditions.

The sites discussed are the Naval Construction Battalion Center (NCBC) site Gulfport, MS; Bengart & Memel site, Buffalo, NY; and the Montana Pole site, Butte, MT. No detailed site descriptions were provided. There was no discussion of laboratory analysis procedures, QA/QC plan, or the amount of soils used in bench scale tests.

OPERATIONAL INFORMATION: The APEG process for dechlorinating hydrocarbons was utilized and the amount of reagents/time and temperature were varied. Two different reagent loading rates were used. Tests were conducted in slurry form and in-situ at two of the sites (NCBC and Bengart & Memel). Unit cost estimates for soil treatment are not provided. Costs for each bench-scale test run are estimated at $1,000 for PCBs and $2,000 for dioxin. Dioxin tests are more costly due to the complicated analytical procedures. The scope of work for the Montana Pole site treatability study was to see if waste oil containing 100,000 ppb dioxin and 2-3% penta chlorophenol (PCB) could be treated with Galson Terraclene-Cl APEG treatment. The scope of work at the NCBS site was to determine the kinetics of processing dioxin contaminated soil using 30 kg batches in a modified 55-gallon drum reactor unit. The scope of work for the Bengart & Memel treatability study was to determine if PCB contaminated soils could be treated.

PERFORMANCE: The results of the tests on the NCBC site and Bengart & Memel soils are shown in the table on the following page.

The results of laboratory tests at Montana Pole indicate the reduction had occurred, reducing the dioxin levels from 100,000 ppb to less than 1 ppb after operating the unit for 1 hour at 150°C. The results of the NCBC study showed that the soil from Gulport, MS could be decontaminated by mixing the soil with APEG reagent and heating to 120°C for 7 hours. The results of the Bengart & Memel study indicates the PCB soil could be reduced to less than 50 ppm by adding reagent to the soil, mixing and heating the soil/reagent mass to 120°C for 12-24 hours. However, no significant correlation appears to exist between performance as measured by the amount of contaminant remaining and reagents used, reagent ratios, time, temperature, or reagent loading for all the treatability studies. Contaminant destruction appears to take place in-situ or in soil slurry form.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02- Dioxins/Furans/PCBs	1336-36-3	Total PCBs
	30746-58-8	1,2,3,4-Tetrachlorodibenzo-p-dioxin
	TOT-DF	Total dioxins and furans

Note: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

Bench Scale Data on NCBC (Gulfport)

No.	Source	Compound	Process	Reagent	Loading	Temp. °C	Time	Concentration	
								Before	After
1	Gulfport	TCDD	Slurry	9:9:2-P.D.K.	100%	250	4 hours	2000 ppb	< 1 ppb
2	Gulfport	TCDD	Slurry	1:1:1-P.D.K.	100%	160	2 hours	2000 ppb	< 1 ppb
3	Gulfport	TCDD	Slurry	9:9:2-M.D.K.	100%	150	2 hours	2000 ppb	< 1 ppb
4	Gulfport	TCDD	Slurry	9:9:2-M.D.K.	100%	100	2 hours	2000 ppb	< 1 ppb
5	Gulfport	TCDD	Slurry	1:1:1-M.D.K.	100%	70	2 hours	2000 ppb	< 1 ppb
6	Gulfport	TCDD	Slurry	9:9:2-M.D.K.	100%	70	2 hours	2000 ppb	< 1.5 ppb
7	Gulfport	TCDD	Slurry	9:9:2-M.D.K.	100%	70	0.5 hours	2000 ppb	< 15 ppb
8	Gulfport	TCDD	Slurry	9:9:2-M.D.K.	100%	50	2 hours	2000 ppb	< 23 ppb
9	Gulfport	TCDD	Slurry	9:9:2-M.D.K.	100%	25	2 hours	2000 ppb	< 36 ppb
10	Gulfport	TCDD	In-Situ	1:1:1-P.D.K.	20%	25	7 days	2000 ppb	1000 ppb
11	Gulfport	TCDD	In-Situ	1:1:1-P.D.K.	20%	70	1 day	2000 ppb	8.5 ppb
12	Gulfport	TCDD	In-Situ	1:1:1-P.D.K.	20%	70	7 days	2000 ppb	< 1 ppb
13	Gulfport	TCDD	In-Situ	2:2:2:1-M.D.K.W.	20%	70	1 day	2000 ppb	3.3 ppb
14	Gulfport	TCDD	In-Situ	2:2:2:1-M.D.K.W.	20%	70	2 days	2000 ppb	2.0 ppb
15	Gulfport	TCDD	In-Situ	2:2:2:1-M.D.K.W.	20%	70	4 days	2000 ppb	2.5 ppb
16	Gulfport	TCDD	In-Situ	2:2:2:1-M.D.K.W.	20%	70	7 days	2000 ppb	< 1 ppb
17	Gulfport	TCDD	In-Situ	1:1:1:3-M.D.K.W.	20%	70	7 days	2000 ppb	3.2 ppb
18	Gulfport	TCDD	In-Situ	1:1:1:3-M.S.K.W.	50%	70	7 days	2000 ppb	2.7 ppb
19	Gulfport	TCDD	In-Situ	1:1:1:15-M.D.K.W.	20%	70	7 days	2000 ppb	43 ppb
20	Gulfport	TCDD	In-Situ	1:1:1:15-M.D.K.W.	50%	70	7 days	2000 ppb	14 ppb

Bench Scale Data on Bengart & Memel (Buffalo)

No.	Source	Compound	Process	Reagent	Loading	Temp. °C	Time	Before	After
21	Buffalo	PCB	Slurry	9:9:2:1-M.D.K.W.	100%	100	2 hours	77 ppm	4.2 ppb
22	Buffalo	PCB	Slurry	9:9:2:1-M.S.K.W.	100%	100	2 hours	77 ppm	6.7 ppb
23	Buffalo	PCB	Slurry	1:1:2:2:1-P.T.S.K.W.	100%	150	2 hours	112 ppm	6.7 ppb
24	Buffalo	PCB	In-Situ	2:2:2:1-M.D.K.W.	20%	70	7 days	77 ppm	3.7 ppb
25	Buffalo	PCB	In-Situ	2:2:2:1-M.S.K.W.	20%	70	7 days	77 ppm	4.0 ppb
26	Buffalo	PCB	In-Situ	1:1:2:2:1-P.T.D.K.W.	100%	150	3 days	112 ppm	<0.1 ppb
27	Buffalo	PCB	In-Situ	1:1:2:2:1-P.T.D.K.W.	100%	150	1 day	83 ppm	<0.1 ppb

REAGENT COMPONENTS KEY

D = DMSO = dimethyl sulfoxide
K = KOH = potassium hydroxide
M = MEE = methyl carbitol = methoxy-ethoxy-ethanol
P = PEG = polyethylene glycol, avg. molecular weight of 400
S = SFLN = sulfolane = tetrahydrothiophene 1.1-dioxide
T = TMH = triethylene glycol methyl ether and highers
W = water

TOXIC COMPOUNDS KEY

TCDD = 1,2,3,4-tetrachlorodibenzo-p-dioxin
PCB = polychorinated biphenyls

Loading (%) = 100 x (reagent mass/soil mass)

NOTE: Quality assurance of data may not be appropriate for all uses.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Physical/Chemical - Low Temperature Stripping

Media:	Soil/Generic
Document Reference:	McDevitt, N., J. Noland, and P. Marks. "Contract DAAK 11-85-C-0007 (Task Order 4) Bench Scale Investigation of Volatile Organic Compounds (VOC's) from Soil." Technical Report AMXTH-TE-CR-86092 prepared by Roy F. Weston, Inc., for USATHAMA (U.S. Army). 120 pp. January 1987.
Document Type:	Contractor/Vendor Treatability Study
Contact:	Eric Kaufman U.S. DOD/USATHAMA Aberdeen Proving Ground, MD 21009 301-671-2270
Site Name:	Letterkenny Army Depot (NPL - Federal facility)
Location of Test:	Chambersburg, PA

BACKGROUND: The U.S. Army is investigating technologies to effectively treat soil contaminated by organic compounds. Low temperature thermal stripping is one alternative which couples two mechanisms: a) removal by volatilization and b) removal by aeration. Two individual studies were conducted to separate the effects of each mechanism. This treatability study evaluates the effects of aeration on VOC removal efficiency.

OPERATIONAL INFORMATION: Soils at the site are gravelly sand fill, and native material consisting of sandy clay and sandy silt. Soils contaminated with VOCs were taken from Area K of Letterkenny Army Depot and is a mixture of these soils. Average concentration of 1,2 trans-dichloroethylene, trichloroethylene (TCE), and tetrachloroethylene were 115, 222 and 95 ppm, respectively. Samples of 4.5 liters each were used in the bench-scale tests. Soils were analyzed for their VOC content and then aerated in a bench-scale aeration unit. The target residence time was 260 minutes. Total VOC were analyzed at the aeration unit outlet. In this manner, the input/output VOC concentration could be determined.

Sampling and analytical techniques are explained for soils, moisture content, temperatures and other variables in the experiments. QC measures in the report include explanations of equipment calibration procedures, analyses of blanks and duplicate samples.

PERFORMANCE: The effect of total VOC concentrations in the soils, air temperature, and soil temperature on the VOC removal efficiency were investigated. Results indicated that VOC removal efficiency is directly proportional to the total concentration of contaminants in the soil. The bottom table shows the results of increasing contaminant concentration on the removal efficiency of VOCs. The same table shows no correlation between soil bed temperature and removal efficiency. As the inlet air temperature decreased, there was an increase in removal efficiency. However, this increase may be due to the corresponding increase in total VOC contaminant levels. There appears to be a correlation between the moisture content of the air streams and the removal efficiency, but the authors suggest additional testing prior to drawing conclusions from the currently available data.

A conclusion in the report is a comparison of VOC removal efficiencies associated with aeration element to the thermal element VOC removal efficiencies. The authors claim that the role of aeration in thermal stripping is minimal (a separate June 86 report is referenced). No data is presented from the companion report concerning the thermal element VOC removal efficiencies. The authors also qualify their statement indicating that their conclusions apply to the conditions evaluated in this study (i.e., inlet air temperature, etc.).

CONTAMINANTS:

Treatability Group	CAS Number	Contaminants
W04-Halogenated Aliphatic Solvents	127-18-4	Tetrachloroethene
	156-60-5	Trans-1,2-dichloroethene
	79-01-6	Trichloroethene
W07-Heterocyclics and Simple Aromatics	1330-20-7	Total Xylenes
W13-Other Organics	TOT-VOC	Total Volatile Organics

Summary of Operating Data

Test Run #	Total VOC Concentration µg/kg	Average Soil Bed Temp (F)	Average Inlet Temp (F)	Average Inlet Air Moisture Content (% by vol.)	VOC Removal Efficiency (%)
1	647	105	163	1.90	55
2	1,538	90	144	2.20	70
3	291,940	115	148	0.80	81
4	2,256,100	102	137	1.00	93

Note: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Biological - Aerobic

Media: Sludge/Generic

Document Reference: Detox Industries, Inc. "Work Plan for Biodegradation of Poly-Chlorinated Biphenyls (PCBs) at a Superfund Site." Technical report of three volumes with a total of about 20 pages and related correspondence. Work plan prepared for General Motors Corporation, Massena, New York. September 1986.

Document Type: Contractor/Vendor Treatability Study

Contact:
Melvin Hauptman
U.S. EPA - Region II
Emergency & Remedial Response Division
26 Federal Plaza
New York, NY 10278
212-264-7681

Site Name: Massena, NY (NPL)

Location of Test: Hearne Utilities, Hearne, TX

BACKGROUND: This document is composed of a work plan and additional technical information which demonstrates the qualifications of Detox Industries, Inc. to conduct remediation of a PCB contaminated sludge at General Motors (GM) plant in New York. Provided are the results of a field demonstration conducted on sludge containing PCB at Hearne Utilities in Hearne, TX. Bench-scale biodegradation studies were also conducted by Detox Inc. on samples of sludge provided by GM from their Massena, NY site. Significant reductions in PCB levels were noted in the tests.

OPERATIONAL INFORMATION: The technical summary provided by Detox Industries, Inc. provides a description of a field test conducted on approximately 500 lbs. of a PCB contaminated sludge at the Hearne Utility site in Hearne, Texas. The sludge was placed into a non-leaking bioreactor open to ambient air. PCB transformer oil was added to the sludge to bring the total PCB concentration to approximately 2000 ppm. The mixture was stirred constantly to ensure aerobic conditions and microbes and nutrients were added to the reactor. Testing time was approximately two months (September 83 - December 83). Samples were provided to NUS Laboratories in Houston, Texas for PCB analysis.

Bench tests were conducted by Detox Industries, Inc. on PCB contaminated sludge samples provided by General Motors from their site in Massena, New York. Samples were inoculated with microorganisms and agitated in a water bath for 16 days. Aliquots were taken and sent to Southwestern Laboratories for PCB analysis.

The technical summaries provided very few details on the microbes that Detox Industries, Inc. has developed for the biodegradation of PCB other than generic statements indicating that oxygen, moisture and nutrients must be present for the process to occur and that Detox Industries microbes are not affected by PCB. The work plan refers to QA/QC procedures, but they are not included in the plan.

PERFORMANCE: The field test at Hearne, Texas showed a significant reduction of PCB from the initial concentration at 2000 ppm. Final concentrations were as low as 0.12 ppm PCB. Results of bench scale tests of samples of PCB contaminated sludge taken from the GM site in New York also showed reductions in PCB levels. The results after 16 days of treatment are shown in the bottom table.

Results of the various studies revealed that the Detox Industries, Inc. biodegradation process reduced PCB levels in contaminated materials. The U.S. EPA approved the GM request to conduct a full-scale pilot study of this process at the GM site in Massena, New York.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02-Dioxins/Furans/PCBs	1336-36-3	Total PCBs

PCB (1248) Biodegradation

	Untreated Soil	Treated Soil	% Reduction
GM Lagoon #1	338 ppm	107 ppm	68.3
GM Digester	110 ppm	63 ppm	42.7
GM Activated Sludge	63 ppm	6.5 ppm	89.6

Notes: a)Treatment time - 16 days
b)This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-24 **Document Number: FCQP**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Physical/Chemical - Low Temperature Stripping

Media:	Soil/Sandy
Document Reference:	Webster, David M. "Pilot Study of Enclosed Thermal Soil Aeration for Removal of Volatile Organic Contamination at the McKin Superfund Site." Journal of the Air Pollution Control Association. Volume 36, No. 10, pp. 1156-1163. October 1986.
Document Type:	Contractor/Vendor Treatability Study
Contact:	David Webster U.S. EPA - Region I John F. Kennedy Federal Bldg. Room 2203 Boston, MA 02203 617-565-3715
Site Name:	McKin Superfund Site, Gray, ME (NPL)
Location of Test:	Gray, ME

BACKGROUND: This paper reports on the results of a pilot study that treated vadose zone soil contaminated with VOCs in an enclosed thermal aeration system. The McKin site, an NPL site in Gray, Maine, was the location of the pilot study. The pilot study was chosen to demonstrate the viability of excavating the soil, treating the soil in a material dryer to aerate the soils and drive off the VOCs, and treating the vapors to remove contaminants. Results of the pilot study revealed that VOCs were reduced to non-detectable levels.

OPERATIONAL INFORMATION: The on-site sandy soil is contaminated with high levels of VOCs including up to 3310 ppm of trichloroethene (TCE) and 1,1,1-trichloroethane. Soils were aerated in a materials dryer at 150°F and 380°F. Three cubic yards of soils could be treated per run and the soils passed through the system from 3 to 8 times to ensure adequate volatilization of the contaminants. Exhaust gases from the materials dryer were treated with a 3-stage process including a baghouse, a scrubber and vapor phase carbon bed to remove particulates and organic vapors prior to release. Aerated soils were solidified and returned to the excavated area.

An important objective of the study was to determine whether ambient air quality could be maintained during soil excavation and aeration. Continuous air quality monitoring for organic vapors was conducted during testing at the site and on the perimeter of the site. Techniques to minimize uncontrolled volatilization of organic chemicals from the soil during excavation and aeration and to control dust emissions were implemented. An on-site laboratory was utilized to augment off-site analysis of soils for organic contaminants by gas chromatography. Methods utilized were EPA Method 8010 and a modified EPA Method 8020. QA/QC is not reported.

PERFORMANCE: Treatability tests were conducted from February to May 1986. During the test, parameters such as drying temperature, dust control and the number of drying cycles were varied to test their effect on the VOC removal efficiency. Test results indicated that high drying temperatures and increasing number of drying cycles produced the greatest amount of VOC reduction. Treated soils were able to achieve the EPA target of 0.1 PPM TCE. The results of various tests are shown in the bottom table.

The results of air monitoring for organic vapors during the pilot study revealed that on-site activities had a negligible effect on air quality at the site perimeter. Pilot test results indicated that concentrations of VOCs can be significantly reduced to non-detectable levels and that thermal soil aeration can virtually eliminate volatile organic contaminants from the vadose zone.

CONTAMINANTS:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Aromatic Compounds	95-50-1	1,2-Dichlorobenzene
W04-Halogenated Aliphatic Solvents	127-18-4	Tetrachloroethene
	79-01-6	Trichloroethene
W07-Heterocyclics and Simple Aromatics	108-88-3	Toluene
	1330-20-7	Xylene

Pre-Aeration and Post-Aeration Concentrations of Detected Contaminants in Selected Soil Aeration Runs (ppm)

	Pre-aeration range	Post-aeration concentrations
Trichloroethene (TCE)	17-115	ND 0.05[a]
Tetrachloroethene	11-19	ND 0.05[a]
1,1,1-Trichloroethane	0.11-0.3	ND 0.05[a]
1,2-Dichlorobenzene	3.5-50	ND 1[b]
Toluene	1-2	ND 1[b]
Xylenes	5-69	ND 1[b]

Notes:
a) Not detected at a laboratory detection limit of 0.05 ppm.
b) Not detected at a laboratory detection limit of 1 ppm.
c) This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

3/90-17 Document Number: FCSF

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: **Physical/Chemical - Low Temperature Thermal Stripping**

Media: Sludge/Oily

Document Reference: Research Triangle Institute. Information: "Input/ Output Data for Several Treatment Technologies." Center for Hazardous Material Research. 10 pp. May 1987.

Document Type: EPA ORD Report

Contact:
Dr. Clark Allen
Research Triangle Institute
P.O. Box 12194
Research Triangle Park, NC 27709
919-541-5826

Site Name: Luwa Corp., Charlotte, NC (Non-NPL)

Location of Test: Charlotte, NC

BACKGROUND: This treatability study is a pilot-scale evaluation of a thin-film evaporator (TFE) for volatile organics (VO) removal from oily sludges such as refinery sludges. TFEs were studied to evaluate their use to remove and recover VO from these sludges prior to land treatment. This would reduce the amount of VO available for release during land treatment of the sludges. The process can also be operated to remove water and low boiling point oils, reducing sludge volume while recovering oil from the sludges prior to disposal. The organics were recovered as a condensate and recycled to the petroleum refinery as product.

OPERATIONAL INFORMATION: The pilot-test was conducted September 8-12, 1986, on non-hazardous (as defined by RCRA) refinery wastes, similar to hazardous refinery wastes such as API separator sludge. The TFE equipment selected included a mechanical agitator device for producing and agitating the film, permitting the processing of high viscosity liquids and sludges with suspended solids. The mechanical agitation at the heat transfer surface promotes heat transfer and maintains precipitated or crystallized solids in manageable suspension without fouling the heat transfer surface. A total of 22 runs were performed using two different wastes, three temperatures, three flow rates and under both atmospheric and vacuum conditions. Five 55-gallon drums of emulsion tank sludge were used on Test 1-18 while the balance of the tests were conducted on oily tank bottoms. Temperatures used were 150°C, 230°C and 310°C. Flow rates of 70-150 lb/hr were evaluated. Sampling and analysis are discussed but no QA/QC is reported.

PERFORMANCE: The fraction of feed removed by the TFE ranged from 11 to 95.7 percent. From 98.5 to 99.5 percent of the VO and 10 to 75 percent of the semi-volatiles were removed from the sludge. Results for VO for the extremes of feed rate and temperature range are provided in the table on the next page. The removal efficiency for volatiles was greater at higher temperatures. At 150°C some of the water in the feed was evaporated along with most of the VO. At 320°C essentially all of the water and VO was removed along with much of the higher boiling point oils. At this higher temperature, the amount of bottom sludge produced ranged between 10 and 13 percent of the feed rate, substantially reducing the amount of material to dispose of. This sludge was still pumpable. The vacuum runs produced a milky-white emulsion as condensate which would require further processing. At 320°C the bottoms product was only 4.3 percent of the feed. This would indicate a two stage process to first remove VO and semi-volatiles at atmospheric pressure and then heavier oils under vacuum operation could substantially reduce the amount of sludge material requiring disposal.

CONTAMINANTS:

Treatability Group	CAS Number	Contaminants
W07-Heterocyclics and Simple Aromatics	71-43-2	Benzene
	100-41-4	Ethylbenzene
	108-38-3	M-Xylene
	95-47-6	O&P Xylene
	100-42-5	Styrene
	108-88-3	Toluene
W08-Polynuclear Aromatics	91-57-6	2-Methylnaphthalene
	83-32-9	Acenaphthene
	208-96-8	Acenaphthylene
	120-12-7	Anthracene
	205-99-2	Benzo(B)fluoranthene
	207-08-9	Benzo(K)fluoranthene
	132-64-9	Dibenzofuran
	91-20-3	Naphthalene
	129-00-0	Pyrene
	86-73-7	Flourene
	218-01-9	Chrysene
	50-32-8	Benzo(A)pyrene
	56-55-3	Benzo(A)anthracene
	85-01-8	Phenanthrene
W09-Other Polar Organic Compounds	117-84-0	Di-n-octylphthalate

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-34 **Document Number: FCSP-**

TFE Volatile Organics Removal for Selected Compounds

	Operating Conditions		Reduction in concentrations from feed (%)[a]			
Test No.	Temperature (°C)	Flow rate (lb/hr)	Benzene	Toluene	Ethylbenzene	m-Xylene
5	150	7[illegible].6	99.58	99.61	99.48	99.54
7	150	153.7	99.73	99.78	98.83	98.64
8	310	68.5	99.72	99.84	99.68	99.67
10	310	143.4	99.76	99.90	99.78	99.75

Notes: a) Based on GC/MS analysis.
b) This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Thermal Treatment - Incineration

Media:	Soil/Generic
Document Reference:	EBASCO Services Inc. "Litigation Technical Support and Services, Rocky Mountain Arsenal (Basis F Wastes)." Six-part technical report with a total of approximately 600 pp. prepared for U.S. Army Program Manager's Office for Rocky Mountain Arsenal Cleanup during April and September 1986 and March, April, and May 1987.
Document Type:	Contractor/Vendor Treatability Study
Contact:	Bruce Huenfeld, U.S. DOD/USATHAMA Aberdeen Proving Ground, MD 21010-5401 301-617-3446
Site Name:	Rocky Mountain Arsenal (RMA), CO (NPL - Federal facility)
Location of Test:	Rocky Mountain, CO

BACKGROUND: This report covers incineration tests ranging from a laboratory test plan and bench-scale test to full-scale testing. This abstract reports only on the results of bench-scale incineration tests of contaminants from Basin F. Objectives of the study were to: 1) gather information on properties of the wastes, 2) provide a bench-scale apparatus to determine incinerability characteristics of the wastes, 3) demonstrate 99.99% destruction removal efficiency (DRE), and 4) determine gas residence time, temperature and excess O_2 necessary for 99.99% DRE.

OPERATIONAL INFORMATION: The wastes discharged into the Basin F lagoon included sodium salts of chloride, fluoride, hydroxide, methyl phosphate, acetate, sulfate and pesticides. Bench-scale tests were conducted on pure compounds and field samples. Equipment was used to simulate three of the major incineration mechanisms--pyrolysis, primary incinerator postflame, and afterburner postflame.

The laboratory bench-scale unit was designed to evaluate thermal destruction efficiency up to 1200°F and residence times from 2 to 5 seconds. The unit utilized a batch load system with two furnaces and a blended carrier gas. The first furnace volatilized the constituents while the carrier gas moved the constituents to the secondary furnace which added O_2 and simulated an afterburner in a full-scale unit.

Residence times in the afterburner were 1 second or 5 seconds and in the primary burner one hour. Primary burner operating temperatures were 650°, 800° and 900° C. Secondary afterburner operating temperatures were 650°, 900° and 1200°C. O_2 concentrations were 5% to 7%. Sixteen successful runs were performed.

The combustion products in the gases were collected by a sampling train for subsequent analysis. A detailed sampling plan is contained in this study. An outline of QA/QC measures that will be taken are reported in the "Draft Laboratory Test Plan for Incineration of Basin F Wastes at Rocky Mountain Arsenal, April 1986." Samples for analysis were collected from soils, sludge and liquid. GC/MS was employed to analyze for ten semi-volatile compounds in the feed stock. GS/MS selective ion monitoring was used for contaminant residue and off gas analysis.

PERFORMANCE: A 99.99% DRE was usually demonstrated for the ten principal hazardous organic constituents. Residues were tested for EP Toxicity to determine the leachability of heavy metals contained in the wastes. No heavy metals exceeded the EP Toxicity limit.

CONTAMINANTS:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Non-Polar Aromatic Compounds	108-90-7	Chlorobenzene
W03-Halogenated Phenols Cresols and Thiols	CPMS	P-Chlorophenylmethyl Sulfide
	CPMS0_2	P-Chlorophenylmethyl Sulfone
	CPMSO	P-Chlorophenylmethyl Sulfoxide
	470-90-6	Supona
W04-Halogenated Aliphatic Solvents	96-12-8	1,2-Dibromo-3-chloropropane
W05-Halogenated Cyclic Aliphatics/Ethers/Esters/Ketones	309-00-2	Aldrin
	72-20-8	Endrin
	465-73-6	Isodrin
	60-57-1	Dieldrin
W07-Hetercyclics and Simple Aromatics	108-88-3	Toluene
	1330-20-7	Xylenes
	ABC	Alkyl Benzene
W09-Other Polar Organic Compounds	109-92-2	Ethoxyethylene
	110-71-4	Dimethoxyethane
	T119-36-8	Benzoic Acid
W13-Other Organics	142-82-5	Heptane
	77-73-6	Dicyclopentadiene

Note: This is a partial listing of data. Refer to the document for more information.

NOTE: Quality assurance of data may not be appropriate for all uses.

3/89-22 **Document Number: FDBP**

Table 1. Destruction and Removal Efficiency of Ten Principal Hazardous Organic Constituents in Overburden Sample

Temp °C in Secondary Burner	650	650	650	900	900	900	900	900	900	900	1200	1200	1200	1200
Temp ° C in Primary Burner	650	650	650	650	800	800	900	900	900	900	650	900	900	900
Gas Residence Time in Second Burner (in seconds)	2	2	5	2	2	5	2	2	5	5	5	2	2	5
Oxygen Level in off-gas (%)	5.4	7	7	5.4	7	7	5.4	7	5.4	7	5.4	5.4	7	7
Run Number	14 17	11	6	18	20	18	12	3	9	7	8	10 13	2	5
% Removal														
ALDRIN	100.00 100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.94	100.00	100.00	100.00	100.00 100.00	100.00	100.00
CPMS	100.00 100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00	100.00	100.00	100.00 100.00	100.00	100.00
CPMSO	100.00 100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.41	100.00	100.00	100.00	100.00 100.00	100.00	100.00
CPMSO2	100.00 100.00	100.00	100.00	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00 100.00	100.00	100.00
DBCP	99.00 100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00 100.00	100.00	100.00
DIELDRIN	100.00 100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.97	100.00	100.00	100.00	100.00 100.00	100.00	100.00
ENDRIN	100.00 100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00 100.00	100.00	100.00
ISODRIN	100.00 100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00	100.00	100.00	100.00 100.00	100.00	100.00
SUPONA	99.74 100.00	99.38	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00 100.00	100.00	100.00

NOTE: **Quality assurance of data may not be appropriate for all uses.**

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process: Immobilization - Solidification

Media: Soil/Generic

Document Reference: Acurex Corp. "BDAT for Solidification/Stabilization Technology for Superfund Soils (Draft Final Report)." Prepared for U.S. EPA. 75 pp. November 17, 1987.

Document Type: EPA ORD Report

Contact: Edwin Barth
U.S. EPA, ORD, HWERL
26 W. St. Clair Street
Cincinnati, OH 45268
513-569-7669

Site Name: BDAT SARM-Manufactured Waste (Non-NPL)

Location of Test: Mountain View, CA 94039

BACKGROUND: This report evaluates the performance of solidification as a method for treating solids from Superfund sites. Tests were conducted on four different artificially contaminated soils which are representative of soils found at the sites. Contaminated soils were solidified using common solidification agents or binders. Samples were tested for unconfined compressibility at various times after solidification and certain samples were subjected to the toxic contaminants/leach procedure (TCLP) tests and total waste analysis. Volatile organics levels were also measured during solidification and long term set up of the soils.

OPERATIONAL INFORMATION: The testing was done on four different types of Synthetics Analytical References Mixtures (SARM) prepared under separate contract for the EPA. The SARMs varied in concentrations from high to low with respect to organics (2,000-20,000 ppm) and metals (1,000-50,000 ppm). Three different binding agents were used; Portland cement, lime kiln dust and lime/flyash (50/50 by wt). Mixtures were molded according to ASTM procedure 109-86 and the Unconfined Compressive Strength (UCS) was measured at 7,14,21, and 28 days after curing according to ASTM 104-86. Optimal percentage of water in the mixture was determined by cone penetrometer tests. Volatile organics (VOC) were analyzed after solidification of the samples using a Gas Chromatograph equipped with a flame ionization detector. Samples were tested on days 14 and 28 to determine whether VOC levels changed during curing. Total Waste Analysis and Toxic Contaminants Leach Procedure (TLCP) tests were conducted on samples having unconfined compressibility greater than 50 psi. This study contains a section on QA/QC procedures.

PERFORMANCE: Compressibility values increased with increasing cure time. The Portland cement samples had the greatest Unconfined Compressibility Test rating (UCS) followed by kiln dust SARM and then the lime flyash SARM samples. The lime flyash samples took up to two weeks to set-up. The amount of water in the samples is critical and has as much effect on the final sample properties as the amount of binder used. Analysis of volatile and semivolatile organics by GC/FID revealed that emissions dropped only slightly during the 14 to 28 day curing process. This observation is consistent with earlier work that revealed that VOC emissions occur mostly during the soil mixing period and are relatively constant during the curing process. The result of the TCLP tests revealed that in certain instances none of the heavy metals could be leached out, however other TCLP results showed heavy metal concentrations greater than those in the initial SARM soil samples. The report contained no analysis or comment on the results of the TCLP tests. The results appear too variable to draw any definite conclusions regarding the ability of solidification agents to immobilize heavy metals.

CONTAMINANTS:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Aromatic Compounds	108-90-7	Chlorobenzene
W03-Halogenated Phenols Cresols and Thiols	87-86-5	Pentachlorophenol
W04-Halogenated Aliphatic Compounds	107-06-2	1,2-Dichloroethane
	127-18-4	Tetrachloroethene
W07-Heterocyclics & Simple Aromatics	100-41-4	Ethylbenzene
	100-42-5	Styrene
	1330-20-7	Xylenes
W08-Polynuclear Aromatics	120-12-7	Anthracene
W09-Other Polar Organic Compounds	117-81-7	Bis(2-Ethylhexyl)phthalate
	67-64-1	Acetone
W10-Non-Volatile metals	7440-47-3	Chromium
	7440-50-8	Copper
	7440-02-0	Nickel
W10-Non-Volatile metals	7440-47-3	Chromium
	7440-50-8	Copper
	7440-02-0	Nickel
W11-Volatile Metals	7440-43-9	Cadmium
	7439-92-1	Lead
	7440-66-6	Zinc
	7440-38-2	Arsenic

NOTE: Quality assurance of data may not be appropriate for all uses.

SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process:	**Physical/Chemical - Soil Washing**
Media:	Soil/Sandy
Document Reference:	IT Corporation. "Laboratory Feasibility Testing of Prototype Soil Washing Concepts." Prepared for U. S. EPA, OHMSB. 47 pp. December 1983
Document Type:	EPA ORD Report
Contact:	Franklin Freestone HWERL - Releases Control Branch Woodbridge Avenue Edison, NJ 08837-3579 201-340-6630
Site Name:	Clarksburg Soil OHMSETT, Leonardo, NJ (Non-NPL)
Location of Test:	Knoxville, TN

BACKGROUND: This draft document reports on laboratory testing of several washing solutions to decontaminate soils contaminated with dioxins. The following extractants were evaluated: surfactant mixtures of 0.5% to 3% Adsee 799 and 0.5% to 3% Hyonic NP90 in distilled water, Freon TF with and without methanol, and kerosene/diesel fuel-water mixtures. A spiked soil was used for the study.

OPERATIONAL INFORMATION: One kilogram of soil was spiked with a solution of TCDD and isooctane. TCDD concentrations were measured using a Soxhlet extraction procedure. The average starting concentration was 0.671 µg TCDD/g soil with a relative standard deviation of 3.78%. The spiked soil was placed into a centrifuge tube, and the solvent to be tested was added at a 3 to 1 ratio of solvent to soil (weight percent). The centrifuge tube was then sealed and placed in the reciprocating shaker for 4 hours at low speed. After shaking, the tube was placed in a centrifuge for ten minutes at 2000 rpm. The clear supernatant was decanted and the residue in the tube weighed. A quantity of solvent equal to the first extract was added to the tube and the procedure repeated until three solvent extractions and a water wash (where appropriate) were completed. The supernatant and the residual soil were extracted and analyzed for TCDD, and a material balance was calculated for the experiment. No analytical QA/QC procedures are described.

PERFORMANCE: The extraction efficiency was measured by Soxhlet extraction of the soil residue after it had undergone three simple batch extractions with a specific solvent system. The study summarizes the data for each of the soil washing solutions. The overall material balance for the extract systems ranged from 94% to 117% with a mean of 101.7% and a relative standard deviation of 6.6%.

The test results indicated that the Freon and Freon/methanol extraction systems were the most effective extractants for the removal of TCDD from the soil. After three batch extractions, 7.4% (50 ppb) and 2.9% (20 ppb), respectively, of TCDD remained on the soil. The overall material balances for these extractions were 101.2% and 96.3%, respectively.

Increasing the concentration of the extractant decreased the residual TCDD concentrations significantly. For example, the residual concentration of TCDD decreased from 27.2% to 13.2% as the concentration of the Adsee/Hyonic increased from 0.5%/0.5% to 3%/3%.

Other variables which may impact the extraction efficiency include the organic content and the soil moisture content of the soils. The organic content of the soil will affect the amount of organics that the soil will absorb, and the ability to desorb these organics. The soil used in this test contained 0.2% organic matter. The moisture content of the soil will significantly affect the final process design for extractants such as methanol which are non-aqueous and have a limited capacity to absorb water.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02-Dioxins, Furans, and PCBs	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)

NOTE: Quality assurance of data may not be appropriate for all uses.

Chapter 5

References

1. U.S. Environmental Protection Agency, Office of Solid Waste. Proposed Guidance Manual BDAT Interim Guidance for Treatment of Contaminated Soil at CERCLA and RCRA Corrective Action Sites (Revision No. 6). June 7, 1988.
2. U.S. Environmental Protection Agency. Summary of Treatment Technology Effectiveness for Contaminated Soil. Prepared by CDM Federal Programs Corporation for the Office of Emergency and Remedial Response. EPA/540/2-89/053. March 1989.
3. U.S. Environmental Protection Agency, Hazardous Waste Engineering Research Laboratory (HWERL). Superfund Innovative Technology Evaluation (SITE) Program. HWERL Symposium. May 1988.

Appendix A

The description of the contaminant groups that follow were taken from "Proposed Guidance Manual: BDAT Interim Guidance for Treatment of Contaminated Soil at CERCLA and RCRA Corrective Action Sites" prepared for the U.S. Environmental Protection Agency, Office of Solid Waste. (BDAT Report, page 2-2, 8/31/88).

CONTAMINANT GROUPS

W01 - HALOGENATED NON-POLAR AROMATIC COMPOUNDS EXCLUDING PCBs, FURANS, DIOXINS, AND THEIR PRECURSORS.

Halogenated aromatic compounds contain bromine, fluorine, and/or chlorine. This group of compounds contains most of the halogenated Appendix VIII constituents including halogenated benzene, toluene, naphthalene and their derivatives. These compounds are essentially water insoluble.

W02 - PCB's HALOGENATED DIOXINS, FURANS, AND THEIR PRECURSORS

These compounds are classified as a separate group because of the more toxic nature and the more stringent requirements for these wastes. Additionally, wastes containing chemical precursors to these materials (e.g., halogenated phenoxyacetic acid derivatives) are very likely to contain halogenated furans and dioxins as impurities.

W03 - HALOGENATED PHENOLS, CRESOLS, AMINES, THIOLS, AND OTHER POLAR AROMATICS

This group of compounds includes halogenated phenols, halogenated alkyl-substituted phenols, halogenated cresols, halogenated amines, and halogenated alkyl substituted thiols. As a group, these compounds are more water soluble than non-polar halogenated aromatics. In addition, the presence of polar substituents gives these compounds lower vapor pressures and higher boiling points than compounds in group W01 .

W04 - HALOGENATED ALIPHATIC COMPOUNDS

This Group includes all brominated, chlorinated, and fluorinated alkanes, alkenes, and acetylenes and includes many high volume industrial halogenated solvents such as carbon tetrachloride, trichloroethylene, perchloroethylene, and the di- and trichloroethane isomers. The compounds in this group are generally more volatile than those compounds found in groups W01 and W03. These compounds are also generally water insoluble.

W05 - HALOGENATED CYCLIC ALIPHATICS, ETHERS, ESTERS, AND KETONES

This group includes a wide variety of halogenated aliphatic compounds which are primarily used as pesticides or pesticide precursors, and contains heavily-halogenated cyclic aliphatic pesticides as well as halogenated polar aliphatic compounds such as halogenated ethers, carboxylic acids, aldehydes, and ketones. These compounds are far less volatile than those in group W04 and generally are more water soluble.

W06 - NITRATED AROMATIC AND ALIPHATIC COMPOUNDS

The physical/chemical characteristics of this class of compounds are governed by the presence of one or more nitro groups (-NO2). The group includes nitrated aromatic and aliphatic compounds because the presence of the nitro group plays a dominating role in the chemistry of these substances. Nitrated compounds undergo unique chemical reactions due to the presence of one or more nitro groups. for example, nitro compounds can be reduced to their corresponding amines. Many nitro compounds are explosive; therefore, some technologies can only be used with great care when treating these compounds.

W07 - HETEROCYCLICS AND SIMPLE NON-HALOGENATED AROMATICS

The group includes a number of simple nonpolar aromatic compounds and the Appendix VIII heterocyclic compounds, primarily pyridine and a few alkyl-substituted pyridine derivatives. This group includes a number of simple non-polar aromatic solvents such as benzene, toluene, ethyl benzene, styrene, and the xylene isomers. The compounds in this group are generally very volatile.

W08 - POLYNUCLEAR AROMATICS AND HETEROCYCLICS

Because of the unique chemistry of compounds containing fused aromatic and/or heterocyclic rings, these compounds have been placed in a separate group. These compounds have much higher boiling points than the simple aromatics in group W07 and have low aqueous solubilities.

W09 - OTHER POLAR NON-HALOGENATED ORGANIC COMPOUNDS

This grouping includes many classes of polar organic compounds such as:

- Non-halogenated phenols, phenylethers, and cresols
- Aromatic and aliphatic alcohols
- Aromatic and aliphatic aldehydes and ketones
- Aromatic and aliphatic nitriles and isocyanates
- Sulfonic acids, Sulfones, thiols
- Phosphate esters, carboxylic acid esters, and sulfate esters
- Amines, substituted hydrazines, and nitrosamines.

All of these compounds exhibit reasonable water solubility and biodegradability.

W10 - NON-VOLATILE METALS

The various Appendix VIII toxic metal compounds can be divided into two classes: those containing volatile metal salts and those containing non-volatile metal salts. Non-

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volatile metals are defined as those not possessing significant vapor pressures below 1000°C. The non-volatile metal salts are those containing nickel, beryllium, chromium, and barium.

W11 - VOLATILE METALS

Volatile metals are defined as those possessing significant vapor pressures below 1000°C. Volatile metals include compounds of lead, zinc, cadmium, and mercury.

W12 - OTHER ORGANICS

This group includes a wide range of inorganic compounds not containing the Appendix VIII or EP-toxic elements listed in the W10 or W11 groups. Compounds contained in this group include fluoride salts, inorganic cyanide salts, sulfides, and phosphides.

W13 - OTHER ORGANICS

This group contains those organic compounds which do not belong to groups W01 through W09.

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